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Special Interest in Concrete

That widespread interest is being given to the subject of good concrete is reflected in the unusual response to Nathan C. Johnson's article, "This Material—Concrete," which appeared in *Engineering News-Record* in four installments from Jan. 24 to Feb. 21. Many requests for a collected publication have been received.

A pamphlet reprint is being prepared, for issue about March 15. As the edition will be limited, orders for copies should be sent promptly to assure their being filled. The price is 25c. per copy.

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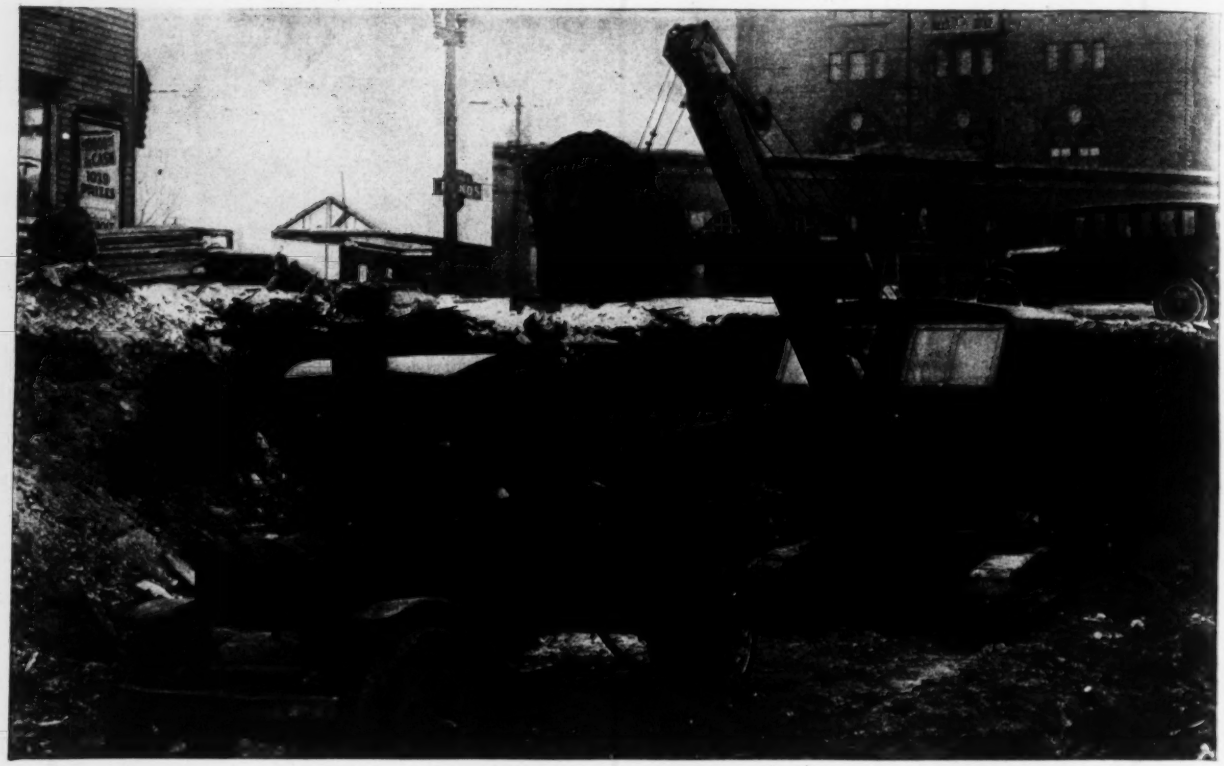

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Volume 102 NEW YORK, MARCH 7, 1929 Number 10

Trained as Engineers

INCLUSION of Robert P. Lamont in President Hoover's Cabinet adds another man of engineering training to the executive staff of the incoming government. Yet Secretary Lamont cannot, strictly speaking, be classed as an engineer. He is rather a business man trained as an engineer who may be taken as typical of a large number of men in business today who as young men studied engineering as the most attractive field to them, only to find after they got into practical work that business or some industry allied to engineering was more suited to their developing abilities. Their success should bring encouragement to many young men now in college who are beginning to have misgivings as to the value of their engineering training as compared with that for some other profession. The careers of such men as Secretary Lamont, and to an appreciable degree that of President Hoover himself, are a clear indication that in this day an engineering education is an asset of unquestionable worth no matter what line of activity a man may follow in his more mature years.

Serving Air Transport

SELDOM, if ever, has a field of activity opened more rapidly for the civil engineer and the contractor than that represented by the development of the modern airport. Municipal airports totaling 425, private and commercial airports totaling 450 and an estimated airport expenditure of $75,000,000 during the current year are figures to conjure with. The many new problems created by this development have been successfully solved for immediate needs. But the requirements are rapidly growing, and it is clear that future airport engineering must be co-ordinated much more closely than in the past with the needs of the airplane itself: its servicing, its landing characteristics, its constantly increasing weights and its changes in design. With the importance of such co-ordination in mind, it is a satisfaction to learn of the merger of the oldest magazine of air navigation with the McGraw-Hill Publishing Company. *Aviation* has for twelve years done pioneer work in guiding aeronautical development. Through the aid of *Aviation's* editors and its widespread sources of information, *Engineering News-Record* will be enabled to supply the civil engineer more completely with the data and news of air transport and to assist better in the extension of sound engineering and construction practices in air terminal development.

Structural Welding Data

STEADY accumulation of data on the performance of fusion-welded structural parts promises well for the progress of the new art involved. An interesting addition to test facts is made by the results obtained with heavy plate connections as reported in this issue. Connections of this type are at first glance not very attractive subjects for welding, as any lack of uniformity might be expected to have an unfavorable effect by virtue of the irregular tearing action that can develop. The satisfactory character of the results is reassuring. The tests further illustrate anew the practical equivalence of a pair of weld beads and a rivet line of normal arrangement even in parts of large size. They tend to show that welded connections are available for practical consideration in massive special structures of complicated assemblage. As new data thus are brought together, the background of empirical fact on which so diversified an art as steel construction necessarily rests is extended most usefully. Sound development of welding depends on due continuance of the process.

Quicksand Hazard

QUICKSAND is a term which has a connotation of real terror to the public and one hardly less disturbing to the excavating contractor. With the mere suspicion of quicksand occurrence in a trenching or foundation job the contractor's concern over excavation hazards is spurred to alarm. The price bid reflects this alarm in proportion as the possible extent and character of the quicksand conditions are indefinite. It is with particular interest therefore that attention is directed to the sane discussion in this issue of quicksand as a trenching hazard. Means of handling quicksand are pointed out. None of them is unfamiliar and none is particularly difficult of execution. Of more importance is the insistence that quicksand is a condition of certain materials rather than a specific material, and this being so, it is a simple task in contract writing to protect the prices of the work as a whole by adjustments of payment directly in proportion to actual extra expenditures for quicksand conditions. The outline of methods offers suggestions which deserve thought.

Seeking for Quiet

FOR years our living conditions have drifted continuously toward more universal and pervasive disturbance by noise and vibration—phenomena that are closely related as to both character and source. Present indications are that increasing value will attach to the prevention of such disturbance and to protection from its influence. The current interest in noise insulation, referred to in this column a few weeks ago, is an indication of the trend. But those mechanical disturbances which originate in traffic and machine operation are also receiving some attention, as in the work reported by S. E. Slocum. In this field knowledge of both facts and methods is still highly primitive. The relation of the subject to human comfort and efficiency, moreover, is hardly capable of direct estimation, and will probably have to be deduced mainly from the amounts of money that men are willing to pay for diminution of the disturbance. Two ready instances throw some light on the matter: the large ex-

penditures that railways find profitable to improve the smoothness of passenger train operation, and the corresponding sums invested in riding smoothness of automobiles. Such facts make it appear that intelligent study of sources and transmission of vibration, available means of damping and reducing transmission, can pay large dividends. It is an important field of work for the future—and we believe the near future.

Tangible Evidence

IN THESE days of inquiry into the subject of concrete quality one primary question is whether or not concreting practice has improved in the course of the past decade or two, and if so, how much. It is not hard to discover stray convictions one way or the other, but tangible evidence has been scarce. A noteworthy piece of evidence is now supplied by the long-time comparative figures of concrete test quality compiled by George L. Lucas from the records of the Board of Transportation of New York City. The data represent the performance of a large number of contractors engaged during fifteen years or more on rapid transit subway construction and related work. A wide range of conditions is involved, about the only reasonably constant factors being the character of the aggregates and the methods of supervision. The fact that under these circumstances a consistent and surprisingly large increase in quality of concrete was realized reflects quite clearly a definite raising of the general level of the concrete-making art. Both the skill of contractors and workmen and the influence of specification control of practice are involved in the advance. It is true that the quantitative data are for strength alone, but, especially in view of the uniformity of cement quality, it appears reasonably certain that the improvement resulted mainly from better balancing of mixtures and more thorough incorporation, all tending to produce denser and more homogeneous concrete. This is most encouraging evidence in its bearing on the permanence that may be expected from modern concrete as compared with that made fifteen years ago. It is equally encouraging as a demonstration of what may be accomplished through consistent educational evolution within a craft. Perhaps there is room for further improvement in concrete along the same line of advance.

Street Widths

ALL through the country the 4-rod street is being platted by real estate operators, following a precedent born of an even measure on the old surveyor's chain. The chain has long since become obsolete, but its derived street width remains to plague us. For 100 years, said Robert Kingery, manager of the Chicago Regional Planning Association, in recently addressing the American Association of State Highway Officials, custom has decreed a 4-rod width, and until four years ago the same old mistake was being repeated in the Chicago region. Pavement widths when measured in traffic units of width do not conform to a 66-ft. right-of-way width. Where a 40-ft. country highway should widen out to 56 ft. in suburban territory, such a roadway cannot be placed on a 66-ft. right-of-way after allowing space for sidewalks, lamp posts, fire plugs, shade trees and other "street furniture." In Chicago alone well over $100,000,000 has been spent on widenings, and every city of the country has expensive widening programs ahead of it. A remedy for the future, applied in the Chicago region during the last few years, is to lay out wider streets in the original subdividing. At the instance of the Chicago organization mentioned, seven counties and 34 municipalities have adopted subdivision rules whose effect so far has been that 500 miles of 100-ft. and 80-ft. rights-of-way have been dedicated by subdividers where otherwise the old-time 66-ft. widths would have been laid out. Another remedy for the future, the establishment of building set-back lines, is likely to find extensive application since a recent Supreme Court decision supports its legality. The subject of street and highway widths has had far too little attention heretofore. It needs a great amount of more thorough and farseeing study, both in the matter of original subdivision layouts and in the determination of widenings in areas already built up. Without such study to determine the capacity required for the specific case and to provide for that capacity, the difficulties now being encountered are likely to come up again at a later period, and most probably in even more serious form.

A Notable Study of Concrete Mixers

OUR policing of concrete in the mixer is careless. With direction and control of the materials before mixing, they are forgotten like a thief in jail while they are in the mixer, and watch and check are resumed only after the product is discharged to do work in the world. What happens in the mixer which may influence, for the good or evil of concrete, the materials committed to it is an inquiry which has not been pressed. This is not highly creditable to engineering practice. As the tests by Prof. A. N. Talbot summarized in this issue indicate clearly, many things happen in the mixer which are of deep significance to the concrete designer and builder.

Outstanding is the lesson that mixing is the vital process of concrete manufacture. The mixer is the agency which performs this process invisibly, to a variable schedule fast or slow as commercial requirements and construction conditions determine and by the direction of an operator whose only concern is the mechanical functioning of the apparatus, the levers of which he swings in designated sequence. The process is intricate. Three inert materials have to be amalgamated with one that is potentially active, in the precise arrangement and relationship that produce the best artificial stone. The mixer has to perform this amalgamation automatically. The engineer can only feed the proper materials in order and time and run the machine in a manner which facilitates its task. The mixer must do the mixing. In driving home this fact the Talbot tests are of the highest order of importance.

There follows the lesson that mixer action and characteristics are as profitable subjects for engineering investigation as is mixer product. Even a superficial count of the ways indicated by the tests in which the mixer may influence concrete quality brings conviction that a fertile field lies open for research. It is perhaps possible that at present as much knowledge of concrete quality production can be uncovered here as in the better worked fields of materials and mixture control. The present study may indeed be indicative of this thought. Certainly it is indicative of a new conception of equipment-manufacture engineering which sees the field of equipment research as its own and grasps the privilege of developing it—not by mere trial and discard of machine designs as in the past but by scientifically conducted tests.

With all agreement in the broad lessons of the Talbot mixer study the practical builder in concrete will ask what these tests have given him that he can put to actual use. It will gain nothing to recite here the findings that are stated better in the test records, but there are certain conclusions indicated by the tests which carry rather broad implications of doubt of the value of certain commercial developments in concrete-manufacturing equipment. One is that body or drum length has a detrimental effect both on quality of mix and on speed of discharge. The other is that if any major proportion of the mixing water is contained in the aggregate when it enters the mixer the effect is disadvantageous to perfect mixer action. Another conclusion which is of significance in view of modern trends toward drier and richer concrete is that such mixtures put greater exactions on mixer design and care and operation.

The argument cannot be developed further, but there is apt to be contention over at least two of the conclusions cited. As, however, the conclusions were arrived at through tests, it is not out of order to suggest that tests will be the best means of controverting them if they are not justified by fact. Indeed, it may be somewhat positively asserted that no method of concrete making has any longer a right of appeal to engineers if it is not supported by research studies. Concrete has reached a time in its trial as an enduring construction material when its manufacture cannot longer be toyed with by every device which invention can conceive. It is because it is in line with this thought that the mixer study under consideration commands attention. It is hoped, and not the least by Professor Talbot, that it will be carried farther to cover other types of mixers and many more variables.

Some Reasons Why

MUNICIPAL utility service has reached a high level of excellence by virtue of modern engineering skill. The citizen's daily necessities and conveniences are so well met that he has little occasion to think of them in normal times; supply of water, light and power, and removal of sewage, are almost as regular and trouble-free as the supply of the air which he breathes. In contrast, the collection and disposal of refuse—garbage and rubbish—is often inadequate. The art is far enough advanced to make good service possible, if only the best collection and disposal plant is provided and kept under efficient operating management. But many cities have only partial service, often poorly administered.

One path of improvement lies along the line of intensive systematization of all the operating elements of both collection and disposal. With this, and with an administrative plan so devised as to put a premium on trouble-free operation, it should be possible to reduce present weaknesses of refuse disposal very greatly.

The prospect for extensive improvement beyond this point is not particularly bright, but this is due to the faults of general municipal administration rather than to inability of engineers to provide as good service in this as in the utility fields if only they are given an equal chance. Recent new incinerators in New York City, including the ninth in Queens Borough, described in our issue of Dec. 6, p. 845, show what good engineering design can do in the provision of one type of garbage- and refuse-disposal plant. The three incinerators now being built for the contractor for refuse collection and disposal in Brooklyn Borough and the four additional incinerators for Manhattan Borough, for which $5,000,000 has been recently appropriated, give evidence that New York City is making progress in restoring the garbage-disposal system disrupted some years ago for a return to dumping at sea, which latter practice has caused serious pollution along the New Jersey beaches.

The mere substitution of one method of garbage disposal for another (incineration for reduction in New York City), as has been commonly practiced from coast to coast, gives no assurance of satisfactory service, no matter how well designed and constructed may be the plant of whatever type newly adopted. Nor does it give assurance that a new city administration will not shut down a plant built by its predecessor, as was done at New York with new reduction works a few years ago; with an incinerator at Lynn, Mass., two or three years ago; and still earlier with an incinerator at San Francisco, completed fifteen years ago and never put into use. These shutdowns of existing disposal plants and refusals of new city administrations to put into use plants just completed are but a few of the many that might be cited. Similar doings with other classes of municipal works are far less common.

One reason why adequate sewage- and refuse-disposal works are not more commonly provided, and when built under good plans at great cost are so often improperly operated, is that their purpose is the final disposal of wastes, whereas water, lighting and heating systems supply primary wants, vital to comfort, convenience, health and life. Moreover, water, light and heat services produce revenue which is or should be sufficient to meet their cost; therefore, under a proper system of financing they are no drain upon the municipal treasury. In contrast, the entire sewage, garbage and refuse service is a dead load to be carried—the partial exceptions are too few to disprove the rule. Moreover, the householder's need is met when the sewage, garbage and refuse are removed from his premises. As a householder he has absolutely no interest in final disposal of these wastes, however much or little he may be interested as a member of the body politic.

For these and other reasons proper final disposal of sewage, garbage and refuse is and long will remain less general than water, light and heat service, and will remain far inferior. Material betterment of the disposal of wastes of all kinds will not come until a higher and more general civic consciousness is aroused *and maintained*. Spasmodic interest in wastes disposal sometimes leads to large bond issues for the construction of costly plants, but there it stops. Expenditure of the money in construction is rarely watched and safeguarded by the citizens. Still more rarely do they give the slightest attention to how much money is appropriated for operation and whether it is so expended as to bring efficient results at the least practicable expense or rather to serve political ends.

Garbage and refuse collection and disposal will never be such vital services to the householder as water supply, light and heat. But they are important branches of the municipal service. They should be adequate and efficient both in collection coverage and in final disposal. Ways and means should be determined by competent engineering study, and operation should be under able engineering direction. If the individual householder's interest ceases with collection, then as a member of the body politic it should be extended to demand efficient final disposal. That will save the citizen's and taxpayer's pocketbook in the long run, and will redound to the good name as well as to the comfort and livability of the city.

The 450-Ft. Foshay Tower at Minneapolis

Tapering Office Building 32 Stories High Resembles Washington Monument—Heavy Column Sections—Special Wind Bracing—Tie-rods in Concrete Floors—Foundations Carried Into Rock

By Gottlieb R. Magney
President, Magney & Tusler, Inc., Architects and Engineers, Minneapolis, Minn.

THE FOSHAY TOWER, at Minneapolis, Minn., a 33-story structure 89x87 ft. at the base and tapering like the Washington Monument, is the tallest and most unusual office building in the Northwest and presents many special features in its structural design. This tower (Fig. 1) is placed near the center of a plot 165x330 ft., or half a city block, and is surrounded on the three street sides by a two-story steel-frame structure which was built before the tower idea was conceived. It is entered from two opposite streets through an arcade adjacent to the inside property line. Although the tower is joined to the low building, it is structurally independent, thus permitting future development of the surrounding land.

This tower, the design of which was inspired by the Washington Monument at Washington, D. C., is 450 ft. high from the street elevation to the peak of roof. It has a rectangular base 89 ft. 2 in. x 87 ft. up to the second floor, and it is then set back 8 ft. from the inside property line, making it 81 ft. 2 in. x 87 ft. Above this level the corners are beveled and the exterior walls have an inward inclination of $\frac{1}{8}$ in. to the foot, reducing the size to 58 ft. 2 in. x 64 ft. at the top of the parapet wall of the facade, about 10 ft. above the level of the 31st floor. At 5 ft. below this parapet is the first setback for the roof, and an observation platform extends around the roof at this point. The exterior walls are of 4-in. Bedford stone with common-brick backing which varies in thickness so as to form vertical interior surfaces. Windowframes and sash are of steel. Interior partitions are built of gypsum and hollow clay tile. There are four electric high-speed elevators, of which one extends as high as the 30th floor.

Framing—Above the second floor the structural frame consists of 21 main columns, with two additional columns for each beveled corner, making a total of 29 columns, of which twenty are inclined and nine are interior vertical columns, as shown in Fig. 2. All columns are of H-section, the larger ones being built up, as shown in Fig. 3, while the two at each corner are rolled H-beams. Typical interior columns consist of a central H-beam, with a pair of I-beams whose webs are riveted to its flanges, while batten plates are riveted across the I-beam flanges. Exterior columns are of similar construction, but below the first floor in the east foundation wall they are double, consisting of two H-sections riveted flange to flange and having their webs at right angles to the wall. Fig. 4 shows the erection of the framing, with the change from rectangular to octagonal plan at the second floor.

Floor framing consists mainly of I-beams, a typical arrangement being as shown in Fig. 5, third floor. There are plate-girders, however, in the second floor, where the change of column layout begins. They are introduced also at the 27th and 31st floors to provide additional stiffness and to carry the offset columns which are required for better utilization of the space.

FIG. 1—THE FOSHAY TOWER DURING ERECTION

Floors and Conical Roof—In the first story the distance between finished floors is 21 ft. 9 in., and in the second story 14 ft. 8 in. Above the third floor this distance is reduced gradually to 12 ft. 4 in. at the sixteenth story, which height then continues to the 27th story. In the second to the 26th story, inclusive, the ceilings are furred down to a uniform story height of 10 ft., thereby concealing all horizontal piping and most of the steel knee bracing. All floors are of reinforced concrete, either as flat slabs or of slab and joist or dome construction, as noted more fully in regard to wind bracing.

In the design a 100-lb. load was assumed for the basement, first floor and attic, with 75 lb. for the rest of the building, except in special cases where the live load was increased sufficiently to support mechanical equipment. For foundations and columns, a reduction of 5 per cent of the live load per floor was allowed

until 50 per cent of the full live load was reached, this 50 per cent load being then used for the remaining floors.

For the pyramidal roof (Fig. 7) steel framing is used, with continuous concrete beams at certain elevations. These beams are supported on top of the inclined rafters by means of clip angles having huge lugs which extend into the concrete and thus tie together the steel and reinforced-concrete members. The concrete beams are connected by concrete struts at each rafter line. A 2-in. reinforced-concrete slab is placed between the beams to form a rainwater gutter. Steam coils under the slabs will prevent the accumulation of snow and ice in these gutters.

All structual steel is incased with concrete having a minimum thickness of 2 in. as fireproofing and to prevent corrosion. Although the steel is designed to take all combined stresses from bending and direct load, this concrete protection will add materially to the stiffness of the building.

Wind Loads and Bracing—On account of the small base dimensions of the tower in proportion to its height, wind action was an important feature in the structural design. The Minneapolis building ordinance requires provision for 30-lb. wind pressure load from the grade line to the top of the building. This pressure is equivalent to a wind velocity of about 100 m.p.h. The allowed fiber stress in the structual steel, according to the local building code, is 18,000 lb. per sq.in. for dead and live loads, except that for columns a fiber stress of 15,000 lb. is permitted. For combined wind, dead and live loads, the stresses used were 22,500 and 24,000 lb. per sq.in.

Typical wind bracing at connections of floor beams and spandrels with both interior and exterior columns (Fig. 6) consists of top and bottom brackets on the beams, with a pair of vertical angles for the column connection. At interior columns the top bracket, instead of resting on the top of the beam, as in the spandrels, is made up of two angles or channels which are fitted beneath the top flange and have their legs riveted against the web of the beam, thus keeping these connection below the floor line.

For determining the bending moments and direct stresses in columns and beams on account of wind pressure the cantilever method sponsored by Robins Fleming was used. The connections between columns and girders or beams were designed to take not only the shearing stress from floor load above but also the bending moment from wind pressure. In order to eliminate the wind-bending action in the tall 30-ft. lengths of interior columns passing through the boiler room (below the basement) diagonal steel bracing was placed in the basement floor framing (Fig. 5). Thus the horizontal wind forces at this elevation are carried to the exterior wall columns and thence down to the piers by means of vertical steel bracing between the wall columns (see Fig. 2).

This diagonal bracing in the basement floor also takes care of the twisting action from wind in the lower part of the tower. A similar system of diagonal bracing was provided in the second floor framing, also shown

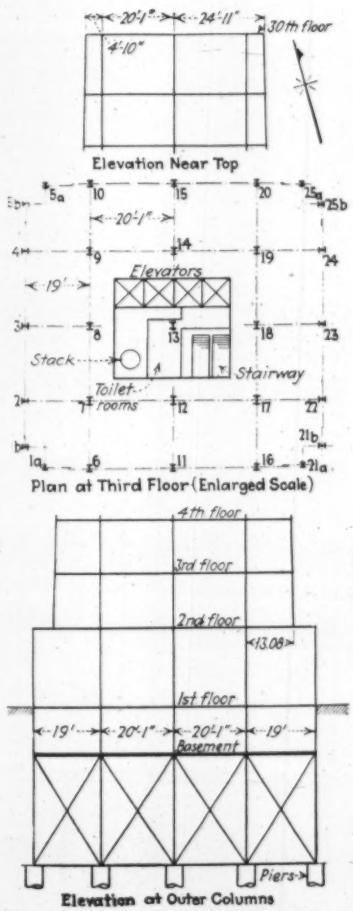


FIG. 2—PLAN AND ELEVATION OF FRAMING

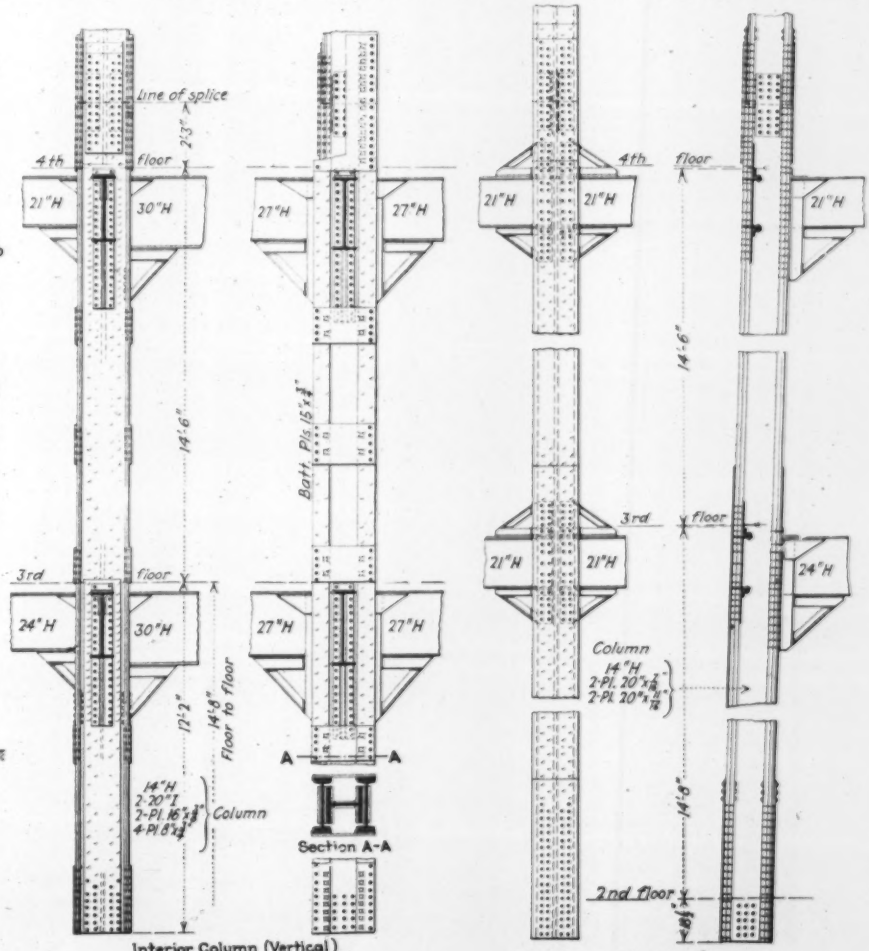


FIG. 3—TYPICAL COLUMN DESIGN

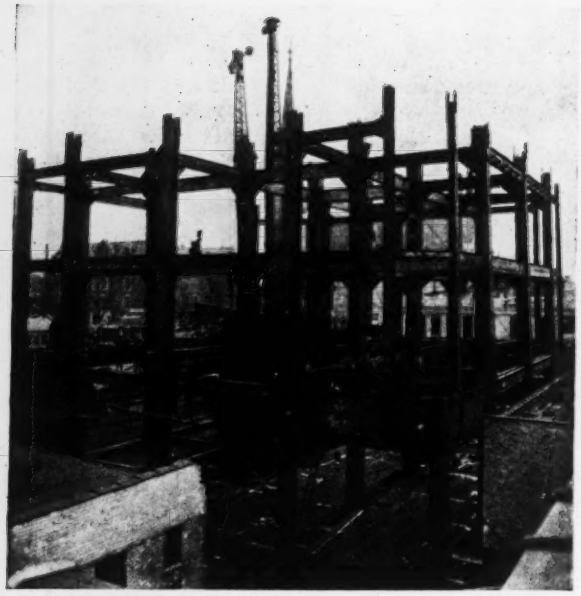


FIG. 4—ERECTION OF TOWER FRAMING
Note change of columns at second floor level, from rectangular plan below for octagonal plan above.

in Fig. 5, to take the twisting action from wind in the lower part of the superstructure. The members of this horizontal bracing were supported at midspan until the concrete floor slab was filled in and embedded them. To obtain additional stiffness against wind the reinforced-concrete dome or cellular type of construction (with joists in both directions, forming rectangular domes) was used in the outer floor panels, except where solid concrete slabs occur. In this design the domes are 8 in. deep with a 2½-in. top slab and the 5-in. joists are 25 in. c. to c. Additional stiffness was secured by reinforced-concrete walls extending from the tops of window openings to the steel spandrels. In each floor there are four transverse lines of ⅞-in. tie-rods, extending between the corner columns, as indicated by the third-floor plan in Fig. 5.

Foundations—In a building of this type the foundation is a very important part of the design. The steel columns are supported on double-tier I-beam grillages incased in reinforced-concrete piers which are combined (at the top) by heavy concrete struts reinforced by steel bars. These struts are assisted by structural steel sections connecting the bases of the columns. The struts were not computed to take any vertical load but to take care of the horizontal forces of wind and earth pressure at the base of the tower, properly proportioning these forces to all piers.

The site was excavated through earth and gravel to the bedrock at a depth of about 50 ft., the surrounding earth and buildings being supported by a retaining wall (of cofferdam) within the excavation. Open wells for the piers were extended through various strata of broken limestone, soapstone and clay to a solid limestone ledge. On account of undesirable bearing qualities of the upper stone ledges it was necessary to extend these wells into the rock for approximately 14 ft., where solid footing was reached. Standing water was encountered about 6 ft. below the top of the ledge. Trouble with the water below this elevation was practically eliminated by excavating 17 ft. into rock for the pier carrying the chimney, this well being then used as a sump for the water which drained through the stone crevices from the other wells and was pumped into the sewerage system.

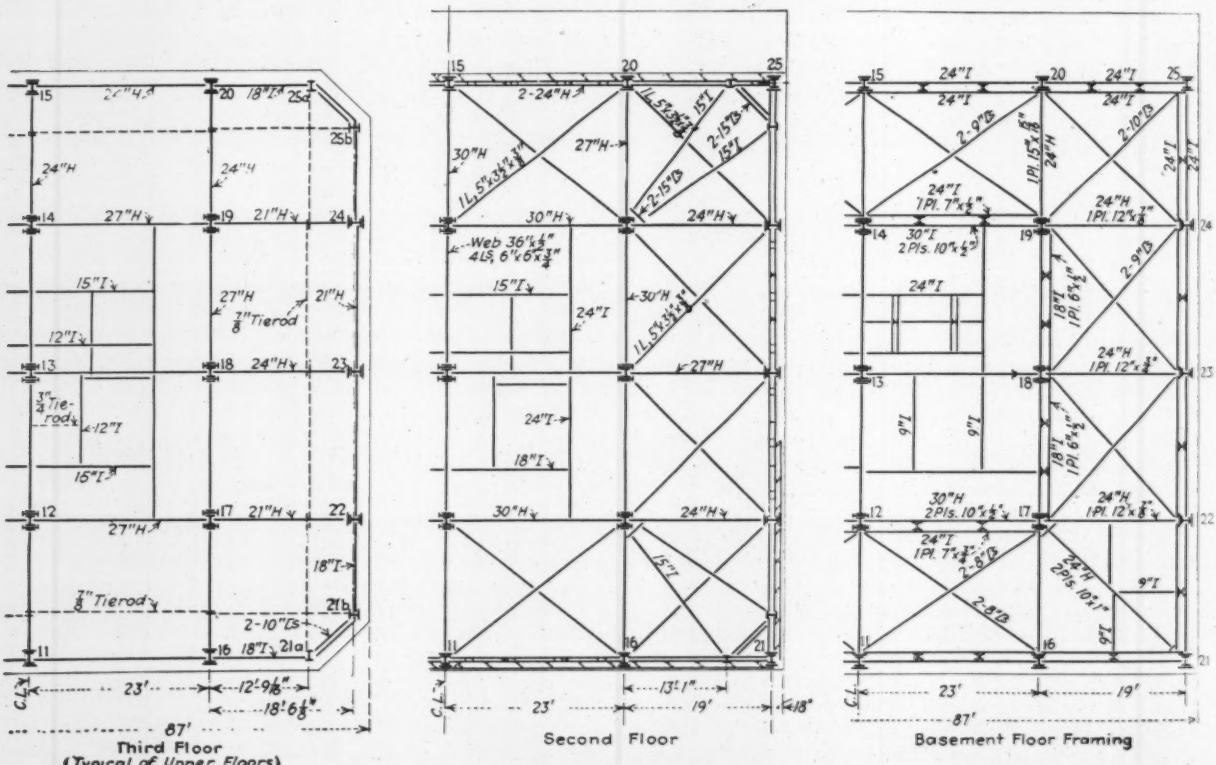


FIG. 5—FLOOR FRAMING PLANS
Note horizontal wind bracing

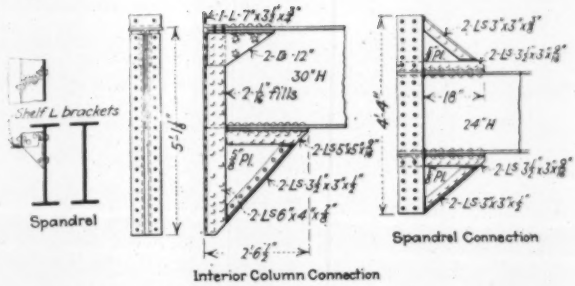


FIG. 6—TYPICAL WIND BRACING AND SPANDRELS

Seams and cracks in the lower part of the wells were calked with oakum. This eliminated the flow of water, and the seepage was pumped out just prior to placing the concrete. By this method it was possible to pour all pier concrete without any interference from water, except that the concrete for the chimney foundation pier was poured under water by means of a tremie.

In pouring the concrete for the piers the procedure was as follows: Concrete was poured to within 6 in. of the elevation for bottom of grillage. The lower tier of grillage beams was placed and supported by leveling devices, after which the beams were grouted to within 3 in. of the top. After the concrete had set the leveling devices were removed and the beams were grouted flush with the top flanges. Then the upper tier beams were placed and grouted flush with their tops, after which the steel slab bases for the columns were set and concrete was poured to within 2 in. of the tops of the slabs.

The structural steel columns and horizontal struts between them were then erected, and the reinforcing steel in the struts and foundation walls was placed, the struts being then filled with concrete up to the under side of the basement floor slab. Reinforced-concrete walls were then constructed between the steel wall columns, these walls receiving the earth pressure against the building.

Designers and Builders—This 450-ft. tower building was designed for the Foshay Company by Magney & Tusler, Inc., architects and engineers, Minneapolis, Minn., who also superintended the construction. The general contractors were Maurice Schumacher and the National Contracting Company, of Minneapolis. Steel erection, handled by the Oscar Daniel Company, up to the fourth floor was done by the Minneapolis Steel & Machinery Company. Above that level it was handled by the Oscar Daniel Company, Chicago, which began on July 12, 1928, and completed the work on Oct. 5. The building will be ready for occupancy about April 1.

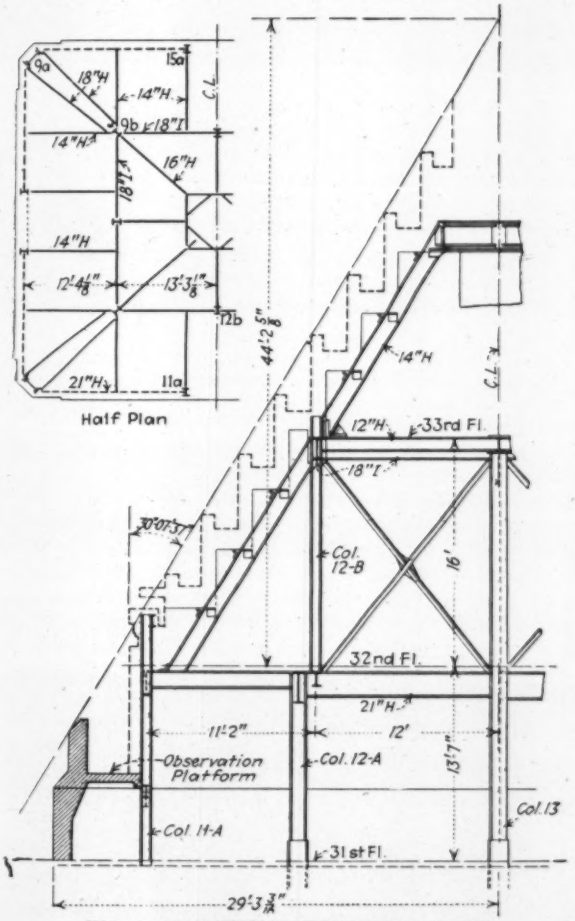


FIG. 7—FRAMING OF PYRAMIDAL ROOF

THE FOSHAY TOWER COMPLETED

Asphalt Grouting Used in Shaft Sinking

Asphalt grouting is being used in the sinking of a 20-ft. salt-mine shaft through water-bearing gypsum to a depth of about 250 ft. into a salt dome near Houston, Tex., for the Texas Salt Company. The shaft is fully lined with concrete. In the early stages of the sinking, cement grouting was depended upon to seal the fissures in the rock and keep out the water carried in them at high pressure. On several occasions the shaft was lost, and was regained only after sealing with a concrete plug. Grouting with asphalt is now being done about 20 ft. in advance of the shaft bottom. In sealing the seam between the gypsum rock and the top of the salt, pressures up to 2,000 lb. per sq.in. are being used.

Finishing Machine Lays Asphalt in Oklahoma

Several Experiments on More Than 40 Miles of Road Indicate High Possibilities of Machine Finishing

By Dudley A. Wood

Engineer of Tests, Oklahoma Highway Commission, Oklahoma City, Okla.

THROUGHOUT the past twelve months the Oklahoma highway department has, through the co-operation of local contractors, conducted extensive experiments in laying black top with standard concrete-finishing machines. Both of the standard makes of machines have, with slight modifications, been successfully used. The initial experiments were on an 8-mile project of modified Topeka-type surfacing on a concrete base course of modified Bates section, 1:3:5 mix.

The 8 miles was subdivided into three sections and each section was subjected to a different finishing process. Section 1 was finished entirely by hand raking; section 2 was thoroughly combed by hand and the finishing machine was used only to improve the riding surface; on

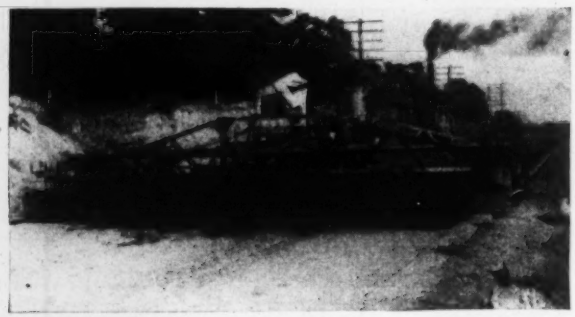


FIG. 1—FINISHING MACHINE WITH MECHANICAL RAKE

section 3 the raking was eliminated and all finishing was accomplished by mechanical means. The surfacing material on the last section was shoveled uniformly high and brought to true contour by the screed of the machine.

On completion of this project specimens were drilled from each day's run to determine the density obtained through the different methods of finishing. The absolute densities of thirteen specimens taken from section 1 range from 2.098 to 2.210, for an average of 2.157. The fourteen density determinations made on samples taken from section 2 disclosed an average density of 2.177, with a noticeable decrease in the spread of the values obtained. The average density of fifteen specimens taken from section 3 was 2.101. The density values obtained from samples of this section showed considerable variation and the average was quite low as compared with sections 1 and 2. This low density as compared with the high value and improved riding surface of section 2 prove conclusively the value of a finishing machine in addition to the raking. A second experiment on a 2½-mile project showed the same results. In view of this fact all concerned gave considerable thought to a suitable mechanical rake.

Since the completion of these projects approximately 30 miles of surfacing has been laid employing a finishing

FIG. 2—SUBGRADE PLANER SPREADS ASPHALT FOR FINISHING MACHINE

machine with varying modifications of the screed and of facilities for raking. In one instance a specially designed screed (Fig. 1), together with an attached mechanical rake, was used. This screed was heated to desired heat by means of a series of blow-torches. The mechanical rake was rigidly bolted to the screed member and conformed to both the transverse and the longitudinal motion of the screed. The teeth were of ¼-in. material set in two rows, one row set on 4½-in. centers and the other on 9-in. centers. Thus with a transverse motion of 5 to 6 in. the surfacing material was thoroughly combed throughout. Since the successful use of this machine all except one of the contractors now using the machine have installed a mechanical rake of suitable design. The screed members are heated by means of pressure tanks and suitable burners.

Fig. 2 shows an ordinary subgrade planer being used in advance of the finishing machine to strike off the surfacing material to a uniform height. The results obtained through its use were very satisfactory. The planer was handled by a small caterpillar tractor operating at some distance in front. The machine in this illustration is a standard machine with only one modification. The gears were reversed to increase the screed motion and correspondingly decrease the forward motion. This modification greatly improved the sealing of the surface.

In all cases the finished pavement has been closely checked for uniformity in depth and density as well as for smoothness, that we may have comparative data between machine-finished and hand-finished pavements. In all cases the density determinations on machine-finished surfaces have been uniformly high as compared with hand-finished pavements. On two projects which were in reasonably close proximity, one being machine finished and the other hand finished, the average densities were 2.186 and 2.129 respectively. The latter is slightly lower than the average density obtained through hand finishing, but the comparison is quite characteristic

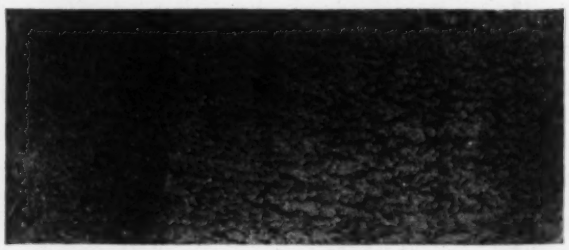


FIG. 3—TEXTURE OF SURFACE GIVEN BY FINISHING MACHINE

of the density obtained through use of the two methods. Thus far the use of the finishing machine is proving most satisfactory both to this department and to the contractors. Its use has materially improved the quality of the finished pavement as well as decreased to some degree the labor costs involved in the laying of the surface. The capacity of the machine is such that it can finish with ease the output of two average portable plants. On one project in this state, which was a 2-in. wearing surface on concrete base, the efficiency of the plant was approximately 30 tons per hour. On this output it was necessary to operate the machine at only 40 per cent efficiency. The average machine is capable of finishing from 6 to 7 lin.ft. per minute.

In the construction of the base course for asphalt wearing surfaces to be finished by machine it is necessary that extreme care be taken on the curb. All sharp irregularities in the curb line are quite naturally transmitted to the surfacing of the roadway due to the difference in elevation of the screed member. The slight irregularities may be offset to some degree by a strip of $\frac{1}{2}$- to $\frac{3}{4}$-in. strap iron laid on the curb. This strap iron also serves as additional curb against which the machine compresses the surfacing to insure a watertight joint along the curbing as well as to insure complete compression at this point.

Tests of Traffic-Vibration Dampers for Buildings

An Experimental Study of Damping Materials at Frequencies of 1,100 to 1,750 Cycles Per Minute

By Stephen E. Slocum
Consulting Engineer, Ardmore, Pa.

THE following article presents in brief abstract the results of some original research on the problem of preventing vibration in structures. This research was undertaken as a special problem involved in the design of the terminal improvements of the Pennsylvania Railroad at Philadelphia, now under construction. The objective was to provide against vibration in future office buildings due to the operation of trains and to street traffic.

The experiments made in connection with this research were performed in the testing laboratory of the civil engineering department of the Towne Scientific School of the University of Pennsylvania, the research facilities of this laboratory having been made available to the writer through the courtesy of Prof. H. C. Berry, director of the laboratory. The original report contains 26 diagrams and figures, five of which are reproduced herewith.

The problem involved is somewhat broader than the title of the paper indicates. Vibration control is a dynamic, as distinguished from a static, problem. Rigid and massive structures are, in general, specially susceptible to vibration, and consequently stability in the structural sense affords no criterion of immunity from vibration. The tests therefore did not stop with the properties of specific materials, but were extended to include certain principles of general application.

The work covered a considerable range of mechanical insulators, including corkboard, felt, rubber, lead, asbestos, sand and gravel. These fall into two general classes —those which possess resilience, such as cork, felt, rubber and asbestos; and those which are non-resilent, such as lead, sand and gravel. All such materials act as insulators (or *isolators*) by destroying the rigidity of the structure at the point where they are inserted, and those which allow the most freedom from restraint serve best for this purpose. To the extent that structural requirements demand rigidity, they restrict the use of vibration insulation; and consequently the usefulness of

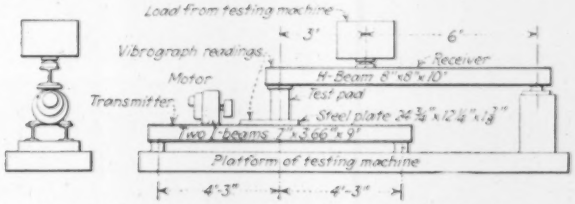


FIG. 1—LOAD-AND-VIBRATION TEST APPARATUS

insulating materials such as those tested is dependent on their durability, compressibility and similar physical properties; or to the manner in which they are applied. There is also the possibility of doing away with mechanical insulators altogether by design of structural members to avoid synchronism, or by articulation of structures at certain points so as to secure stability without rigidity.

Test Apparatus—In laying out these experiments on mechanical insulators it was recognized that their dynamic properties varied with the load as well as with the frequency of vibration. To take both factors into account, test apparatus was arranged as shown in Fig. 1. It consists essentially of a vibration transmitter and a vibration receiver, with the insulating material under test inserted between them.

The *vibration transmitter* consisted of an electric motor with an unbalance on the flywheel, mounted on two parallel steel I-beams. A steel plate bridging the beams at the center formed the platform for the test pad, and also for a Geiger vibrograph, which recorded the generated vibration graphically on a paper roll. The *vibration receiver* consisted of a single steel H-beam, with one end resting on the test pad, as shown. The whole apparatus was mounted on the long test platform of a 300,000-lb. testing machine, by means of which static loading was applied to the H-beam. In this way the test pad could be subjected to various loads, and vibration could be transmitted through the test pad under such loading. The difference in the amplitude of vibration between transmitter and receiver then measured the damping properties of the material under test at the given frequency and loading.

Traffic Vibration—Vibration set up by trains and street traffic is of relatively low frequency, and therefore the apparatus was so designed as to cover this range. A rheostat in the circuit gave a motor speed which could be varied from 1,100 to 1,750 r.p.m., which of course represented the frequency of vibration of the transmitter in cycles per minute. Such variation in frequency in tests of this nature is very important from a practical standpoint, as it is such as actually occurs in vibration due to trains entering or leaving a terminal, or in the case of street traffic under similar conditions of variation in speed. The apparatus did not have the refinement of that expected in physical laboratories, but approximated the actual conditions met in engineering practice. The results are therefore typical of what may be expected "on the job."

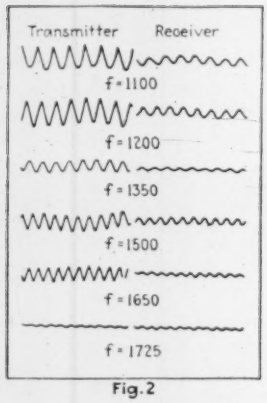


Fig. 2

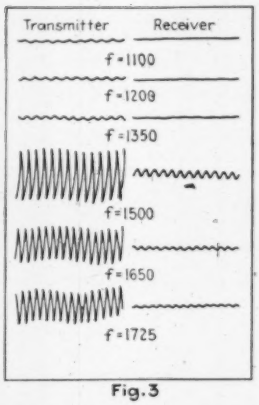


Fig. 3

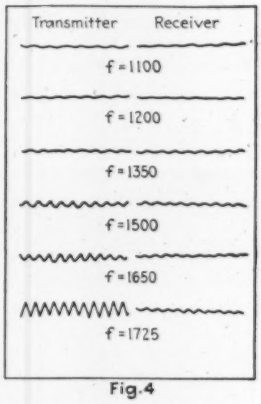


Fig. 4

Figs. 2 and 3—Typical vibrograph records, showing critical points of two kinds. Ratio of received to transmitted vibration measures degree of damping. The curves in Fig. 2, made on a corkboard pad 6x6x3 in. at six different frequencies, show good damping at the lower frequencies but no damping at 1,725 cycles per minute, which thus represents a critical frequency. Fig. 3 shows a critical frequency of another kind; speeding up from 1,350 to 1,500 cycles produced a very large increase in the transmitted amplitude due to resonance of the test system. All curves represent amplitudes in one-third original magnitude. Fig. 4—Multiple pad of lead-and-asbestos type: The test sample was 6x6 in. in size and 10½ in. thick, being a pile of ten 1-in. pads. It was subjected to static loading of 450 lb. per sq.in. during the test.

Corkboard as a Damper—Commercial corkboard is extensively used for insulating purposes for light loads, or where the load is merely nominal, as in the case of lateral insulation, and since its insulating properties are very pronounced it may be used as a datum for comparison of results obtained with other materials.

One of the sets of test results is reproduced in Fig. 2. The percentage of damping was found to vary with the unit load and the thickness of pad. The average value of damping for all six frequencies in the case shown in Fig. 2 was 71.4 per cent. It was found that the damping did not increase directly as the depth but at a progressively slower rate, so that little is gained by increase in thickness beyond a certain limit.

There are two types of critical point, near which the vibration phenomenon is substantially modified from its average or normal appearance. One such point is shown in Fig. 2, where at a frequency of 1,725 cycles per minute the damping practically disappears. The other type of critical frequency is shown in Fig. 3, where the amplitude of vibration suddenly increased about twelvefold when the frequency stepped up from 1,350 to 1,500. The occurrence of such points is due to the fact that the test apparatus formed a compound system consisting of three elements—namely, transmitter, receiver and test pad—each of which had its own natural frequency. The natural frequency of such a compound system does not coincide with that of any individual component in general, but is a function of them all. This accounts for the fact, often noted, that in the case of machinery installations the insertion of a damping pad of improper dimensions may actually intensfy the trouble instead of relieving it. The existence of such critical frequencies also indicates the advisability of using a wide range of frequencies in making damping tests.

Hair Felt, Rubber and Asphalt—Tests were made on a special quality of hair felt known commercially as "Mascolite," an English product used largely in machinery installations. The results indicated that this material is one of the most efficient types of machinery insulation on the market. Load-deflection curves and vibrograph records showed very uniform and consistent damping properties.

Live rubber was tested in the form of cylindrical bushings used for automobile engine mounts. This particular type of bushing was so constructed that the rubber was in shear, and the vibrograph records indicated clearly that live rubber in shear is an excellent vibration damper, although its physical properties are such that its practical application is rather limited.

In tests on liquid asphalt emulsion the particular interest was that this material may be used for pouring in cracks around foundations and piers, or as a binder or waterproofing for corkboard and similar insulation.

Composite Pads — Special attention was given to tests on lead and asbestos pads, or vibration mats, of the type adopted by the New York Central Railroad for insulation of column footings under office buildings in the Grand Central Terminal zone, New York City, and elsewhere (described in *Engineering News-Record*, Feb. 10, 1927, pp. 228-230).

A pad of material identical in make-up with the vibration mats used in the Graybar Building was thoroughly tested, both for its structural properties and as a vibration damper. The report shows a load-deflection diagram carried up to a unit load of 400,000 lb. per sq.ft., one of the interesting features of this test being that there was no appreciable lateral deformation of either the lead or the asbestos even at maximum load. In a second test, arranged to determine the effect of time on deformation or settlement, the unit load was maintained at 800 lb. per sq.in. for 75 hours. The resilience of the pad on removal of load was also determined. This type of lead and asbestos vibration mat consists of a sandwich arrangement with top and bottom layers composed of $\frac{1}{8}$-in. sheet lead, two intermediate layers of $\frac{3}{8}$-in. asbestos millboard and a central layer or core of No. 20 galvanized iron. The nominal thickness of the composite mat is therefore 1 in.

In testing the vibration properties of such mats it was found that, with the apparatus used, a single mat 1 in. in thickness gave no appreciable results. To amplify the damping effect sufficiently to give a reliable indication, ten such mats were piled in series, and with this tenfold amplification good indications were obtained. One of the sets of vibrograph records obtained for such multiple mat is shown in Fig. 4. The load-deflection graph that was obtained with a single mat is shown in Fig. 5.

It is evident that under heavy loads the difficulty of finding a suitable material for a vibration damper is greatly increased. Asbestos, being a natural mineral product, is imperishable, possesses considerable resilience and is otherwise suitable for the purpose in view. However, the lead used in such combination pads seems superfluous either as a vibration damper or as protection for the asbestos.

Damping With Gravel—Special consideration was given to the properties of sand and gravel as vibration dampers. The arrangement for testing such materials consisted of sections of steel pipe of different length, filled with the material, with the load supported on the sand or gravel in the container without touching the pipe

walls. The gravel was obtained from test pits sunk to the level of the subway track foundations.

Within a limit of 2 ft., the depth of the material had no appreciable effect on the damping percentage. Further investigation of this feature led to the conclusion that damping in the case of non-resilient materials such as sand and gravel is a purely surface effect, due to freedom from constraint at the surface of contact. A further study of this principle led to important modifications in subway track construction in the project for which these tests were undertaken.

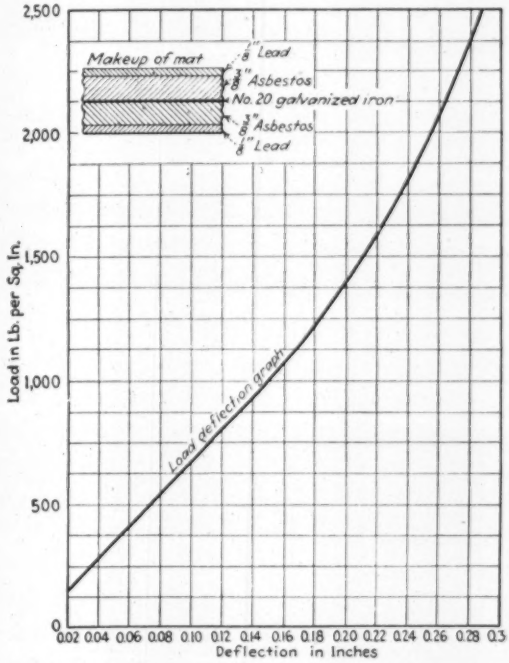


FIG. 5—LOAD-DEFLECTION CURVE FOR SINGLE LEAD-AND-ASBESTOS PAD

Perhaps the most far-reaching feature of these test results is the extension of this principle of damping produced by lack of constraint. In tests made with a solid steel bar, and also with a steel knife edge replacing the resilient test pad, resting freely, there was a very substantial damping of the amplitude of vibration, particularly at light loads; whereas when they were clamped rigidly to the beams the damping disappeared. There are many cases in which this principle may be applied to great advantage in place of or supplementing the use of vibration mats. In particular, this led in the present case to important modifications in the viaduct framing.

Other tests in the series were made to determine the effect of mass damping. Altering the mass was found to change the amplitude and natural frequency of the system. Also, by placing a suitable mass at antinodes, the vibration characteristics of the entire system could be altered at will.

Aerial Topographical Work in Canada

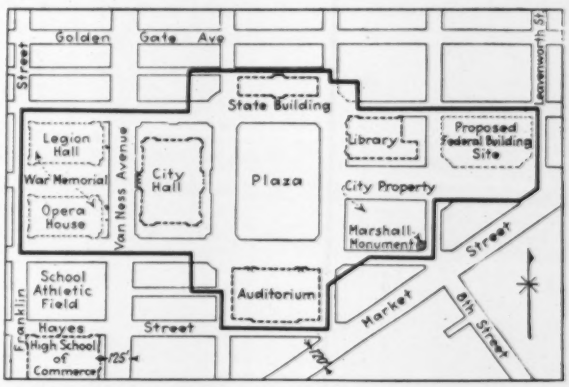
The preliminary report for 1928 of the aerial photographic work for survey purposes done by the Topographical Survey, Department of the Interior, in Canada, in co-operation with the Royal Canadian Air Force, shows in round numbers a total of 53,000 square miles of territory covered. The operations extended into eight of the nine provinces of Canada.

Further Development of San Francisco Civic Center Proposed

THE SAN FRANCISCO civic center, outstanding among American examples of civic planning, is entering a new stage of development in accord with the plan recommended in 1912 by a board of three consulting architects. Addition of three major buildings to the present nucleus is proposed for the immediate future.

The City Hall, predominant in position and proportion, stands fronting a five-acre plaza, upon which also face the Exposition Auditorium, Public Library and California State Building. These four buildings, representing a cost of more than $9,000,000, comprise the present civic center group located just north of the junction of Market St. and Van Ness Ave., two of the city's main traffic arteries. This general location resulted from the desire to utilize valuable city-owned property in the vicinity of the old City Hall, destroyed in the fire of 1906.

Plans are now under consideration for the addition of a war memorial group of two buildings and a proposed federal building. The war memorial group, made possible by combined individual, organization and public effort, will occupy a site covering two city blocks facing the City Hall from across Van Ness Ave. One building will be the Legion Hall and Museum; the other a publicly owned grand opera house. It is noteworthy that such a building was formerly proposed for a site near the old City Hall. Realizing the importance and convenience of a central location for the agencies of city, state and federal government, San Francisco has proposed that the federal government acquire an undeveloped site in the civic center property and build thereon a structure to house the local branches of its various departments. This building, now being considered by national authorities, would add an important unit in the material development and the administrative significance of the present civic center.



PLAN OF THE SAN FRANCISCO CIVIC CENTER
Heavy line marks limits of civic center, including proposed additions.

Progress on Hudson Bay Railway

Good progress has been made on the construction of the Hudson Bay Railway, and the track has now reached Mile 462, within 48 miles of Churchill. Although it has been necessary owing to lack of overland railway connection to proceed with the work of developing a port at Churchill from the sea end, very satisfactory progress has been made on that work also during the past season.

Concrete's 15-Year Record on New York Subways

Control Brings 89 Per Cent Increase in Strength Using Identical Materials—No Failures on Work Involving 8½ Million Bags of Cement—Some Figures on Ready-Mixed Haulage

By George L. Lucas
Division Engineer, Board of Transportation, City of New York

THE HISTORY of concrete is so replete with records of its manufacture, technique and research that there is offered as an extenuation for another contribution the fact that the manufacture and control of concrete for New York subways present a rather unique problem.

Concrete has been used almost exclusively for masonry in the construction of rapid-transit railroads in the City of New York, and among all the structural materials it ranks first in volume and importance. Subways have been building almost continually for 28 years, and the development of concrete to its present-day standard has been an absorbing and interesting study. In the beginning of subway construction the art of making concrete had just reached the end of what might be called the era of dry concrete, relapsing suddenly from virtue into the wet era, from which it is only recently recovering.

Throughout the 28 years of construction no failures of concrete have been noted, which might be construed as indicating that concrete is good no matter how made and that the great amount of work spent in its constant investigation has been, in part at least, unnecessary. This is not the case, however, as the duty placed upon concrete has appreciably increased since the old days.

More Severe Service

In the earliest subway work, concrete was designed so as to avoid tension. It was used in large masses for footings or foundations, in jack arches to transfer loads to the structural steel, in rock and subaqueous tunnel linings and for waterproofing protection. Later, when the possibilities of the combination of concrete with steel were recognized, alternative designs were made, one with bents of steel beams and columns, with the walls, roof and floor of plain concrete, and the other with concrete reinforced with rods.

The design for many years past, however, considers concrete in the same class with other structural materials. Wherever necessary, steel is used to take tensile stresses, and advantage is taken of the combination of steel beams securely held and reinforced by concrete jack arches. Whereas 20,000-lb. flange stress normally is used in steel beams, if the compression flange of the steel beam is securely held and reinforced by the concrete slab or arch, stresses as high as 25,000 lb. per sq.in. are permitted in the steel beam.

From acting solely in compression, concrete soon entered the field where it had to withstand stresses similar to other structural materials, including direct compression and bending and shear; hence the production of concrete of uniformly good quality requiring more care in its manufacture became of major importance. The advance in design, along with the improvement of materials, machinery and processes, creating new and changing conditions, required constant study and experiment.

Today concrete is used for every possible purpose, both below and above ground. It is the one structural material that is not factory made, which is unfortunate, since it is thus susceptible to wide variation in quality. By comparison there is no structural material subjected to so much abuse in manufacture. If it were possible to manufacture concrete under factory conditions with its adequate machinery and equipment, exact control and a continuing organization, the possibilities seem interesting when we consider by comparison the diverse and heterogeneous equipment and methods used in manufacture on construction works, the changing working force and intermittent operation of plants which are here today and gone tomorrow.

Difficulties of Control

The problem confronting the engineers on subway construction is the production of good concrete of uniform quality on all of the works. Considering the great multiplicity of works under construction at one time by a diversity of contractors, the restrictions and limitations caused by environment, heavy traffic and lack of storage space convenient to the works, the general application

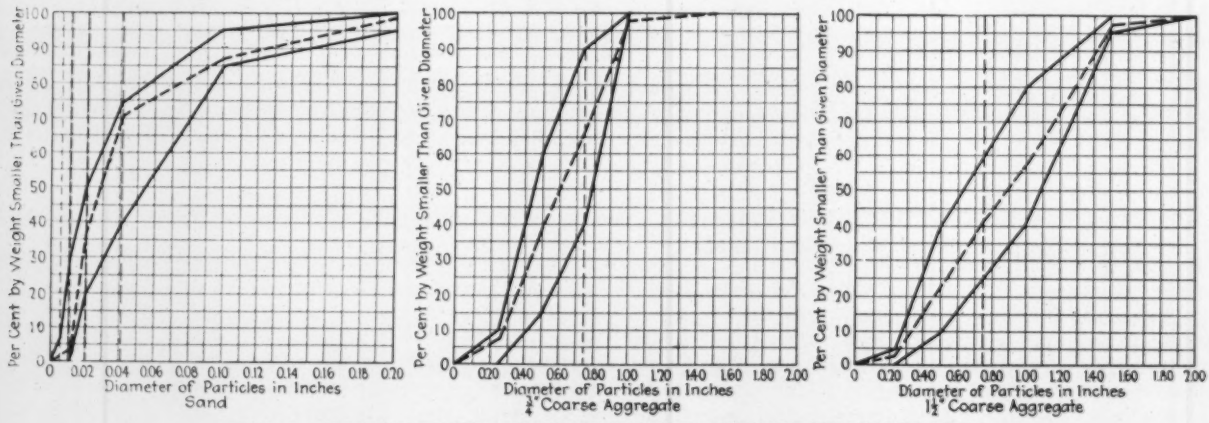

Per Cent by Weight Smaller Than Given Diameter
Diameter of Particles in Inches
Sand
Diameter of Particles in Inches
¾" Coarse Aggregate
Diameter of Particles in Inches
1½" Coarse Aggregate

FIG. 1—GRADING REQUIREMENTS FOR FINE AND COARSE AGGREGATES
Solid lines are fineness and coarseness limits, and materials whose analysis curves are between these limits are acceptable.

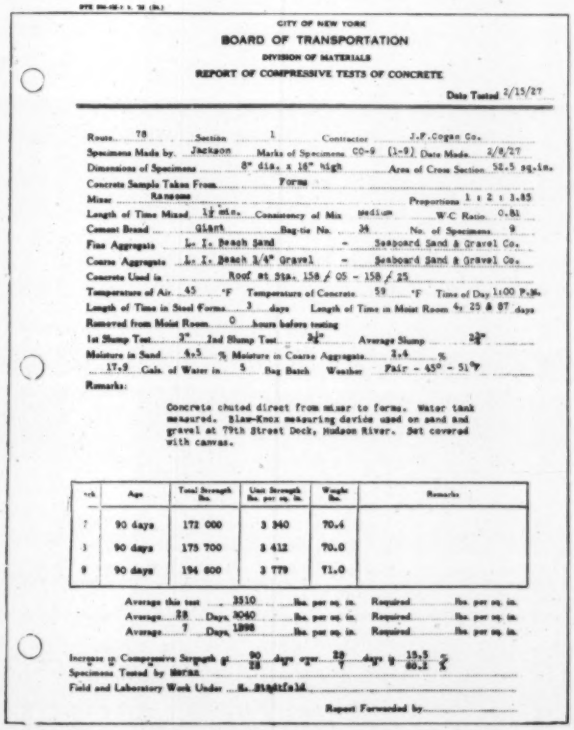
of methods adapted to single works is difficult. For instance, there are now in the course of construction 35 major works, all using concrete, and the situation is further complicated by the large number of individual mixing plants operating at one time over a wide territory. At present there are twelve central mixing plants, 32 portable plants and one commercial central mixing plant, operated by 30 separate manufacturers, the contractors. Cement is furnished to contractors by eleven manufacturers through 21 local dealers, and there are eleven plants producing aggregates which are shipped on barges to eleven docks, from which they are delivered by distributors to the works in trucks. Twelve contractors handle their aggregates from their own docks. For uniformity of product, the problem is rather peculiar.

In the solution of this problem an extensive literature and a mass of data are available, but good common sense must be used in their application. Laboratory tests and experiments must be translated into working and field conditions. The results of research are generally of considerable refinement and must be applied with an eye to economics, as there is a point where the benefits derived from refinement in practice are not commensurate with their cost. The data must be adapted judiciously to local conditions and environment.

Requirements

The principal requirements for good concrete—density, durability and strength—may be obtained by the kind, quality and grading of aggregates, the kind and quality of cement and their proportioning and mixing with the right amount of water. If all these ingredients and their use be properly controlled, good concrete may be produced.

Materials—The specifications for cement are quite similar to standard specifications, except for the age-increase requirement and for tests on neat cement. The fine and coarse aggregate specifications are covered by two short paragraphs, requiring good graded material; broken stone is limited to hard limestone and trap rock. The real specification for aggregates consists of eleven pages of standard-practice instructions, which cover the kind, quality, sizes, grading, methods of tests, silt limits, etc. Sands and gravels are required to be washed, and it is current practice to wash broken limestone.



CITY OF NEW YORK
BOARD OF TRANSPORTATION
DIVISION OF MATERIALS
REPORT OF COMPRESSIVE TESTS OF CONCRETE

Date Tested 2/15/27

Route 78 Section 1 Contractor J.P. Cogan Co.
Specimens Made by Jackson Marks of Specimens CO-9 (1-9) Date Made 2/8/27
Dimensions of Specimens 8" dia. x 16" high Area of Cross Section 52.5 sq.in.
Concrete Sample Taken From Forms
Mixer Ransome Proportions 1 : 2 : 3.85
Length of Time Mixed 1½ min. Consistency of Mix Medium W.C Ratio 0.81
Cement Brand Giant Bag-tie No. 24 No. of Specimens 9
Fine Aggregate Le. I. Beach Sand - Seaboard Sand & Gravel Co.
Coarse Aggregate Le. I. Beach 1/4" Gravel - Seaboard Sand & Gravel Co.
Concrete Used in Roof at Sta. 158 ƒ 05 - 158 ƒ 25
Temperature of Air 45 °F Temperature of Concrete 59 °F Time of Day 1:00 P.M.
Length of Time in Steel Forms 3 days Length of Time in Moist Room 4, 25 & 87 days
Removed from Moist Room 0 hours before testing
1st Slump Test 3" 2nd Slump Test 2½" Average Slump 2¾"
Moisture in Sand 4.5 % Moisture in Coarse Aggregate 3.4 %
17.9 Gals. of Water in 5 Bag Batch Weather Fair - 45° - 51°
Remarks:

Concrete chuted direct from mixer to forms. Water tank measured. Blaw-Knox measuring device used on sand and gravel at 79th Street Dock, Hudson River. Set covered with canvas.

Mark	Age	Total Strength lbs.	Unit Strength lbs. per sq. in.	Weight lbs.	Remarks
7	90 days	172 000	3 340	70.4	
3	90 days	175 700	3 412	70.0	
9	90 days	194 600	3 779	71.0	

Average this test 3510 lbs. per sq. in. Required lbs. per sq. in.
Average 28 Days 2040 lbs. per sq. in. Required lbs. per sq. in.
Average 7 Days 1898 lbs. per sq. in. Required lbs. per sq. in.
Increase in Compressive Strength of 90 days over 28 days is 15.5 %
Specimens Tested by Moran
Field and Laboratory Work Under E. Stightfield
Report Forwarded by

FIG. 2—TYPICAL TEST RECORD

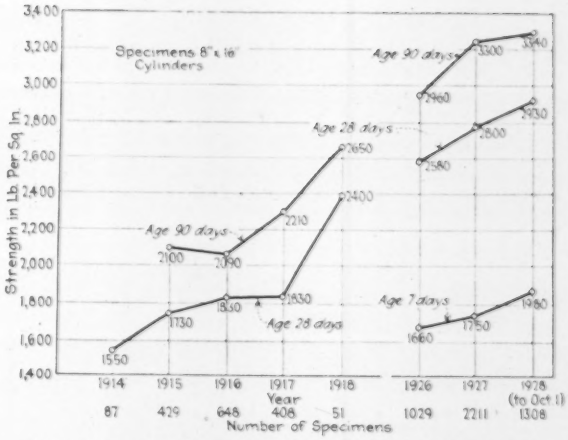


FIG. 3—A RECORD OF FIFTEEN YEARS OF IMPROVEMENT IN SUBWAY CONCRETE

Increases in strength shown are a result solely of controlled manufacture. The same aggregates and the same cement specifications apply over the whole period.

The grading requirements for fine aggregate are shown graphically at the left on Fig. 1, which is part of the standard form of report used by the inspectors at the plants producing sand. Every boatload of sand inspected and tested is reported on this form. The two curves drawn in solid lines show the limitations of fineness and coarseness of sand for concrete, and any sand the analysis curve of which falls within these two is acceptable. Likewise the requirements for ¾-in. and 1½-in. stone are shown in Fig. 1. Fine and coarse aggregates with grading curves falling within the limiting curves fulfill the requirements, according to the best authorities, for the production of density in concrete. The specifications for fine and coarse aggregates were made after a study of the available supply, which is unlimited in quantity in the New York district, produced alongside deep water and manufactured under competitive conditions.

The cement and fine and coarse aggregates are inspected and tested at the source of supply or place of manufacture. The cement is delivered in bags which are sealed for identification on the works, and the fine and coarse aggregates are identified by a method of following through shipments from the producing plant to the docks and delivery by trucks, so that every truckload delivered to the jobs is identified as inspected material. With these precautions in regard to materials in effect, their proper use should result in good concrete.

Proportioning—That part of the concrete specifications governing the making and mixing of concrete requires the ingredients to be proportioned by volume, the essential features of which follow in brief:

Proportion—1 part cement, 2 parts fine aggregate, 4 parts coarse aggregate.

Unit of Volume—¾ cu.ft., the volume fixed for one bag of portland cement containing 94 lb. net.

Water—The maximum amount of water permitted, including moisture in the aggregates, 6¼ gal. to one bag of cement.

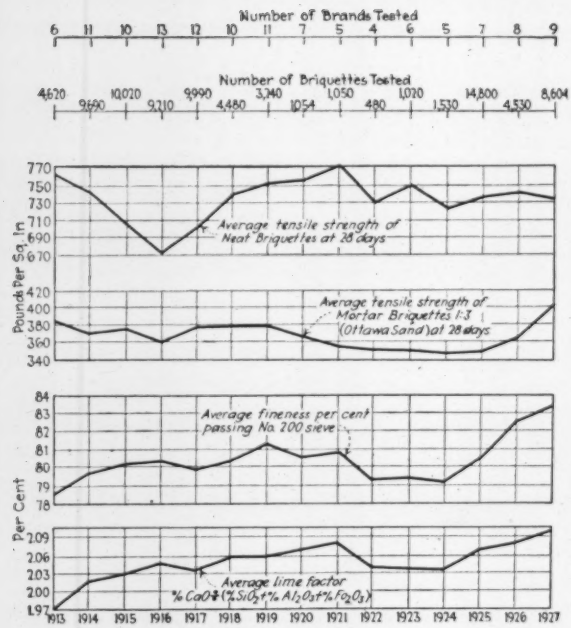

Number of Brands Tested
6 11 10 13 12 10 11 7 5 4 6 5 7 8 9
Number of Briquettes Tested
4,620 10,020 9,990 3,340 1,050 1,020 14,800 8,604
9,690 9,710 4,480 1054 480 1,530 4,530
Pounds Per Sq. In.
Average tensile strength of Neat Briquettes at 28 days
Average tensile strength of Mortar Briquettes 1:3 (Ottawa Sand) at 28 days
Per Cent
Average fineness per cent passing No. 200 sieve
Average lime factor
% CaO ÷ (% SiO2 + % Al2O3 + % Fe2O3)
1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927

FIG. 4—CHARACTERISTICS OF THE CEMENT USED OVER A FIFTEEN-YEAR PERIOD ON SUBWAY WORK

A total of seventeen brands of cement were used, thirteen being the maximum and four the minimum number of brands used in any one year.

Measuring Devices—Exact measuring devices required for aggregates, and all measures must be struck.

Measuring Fine Aggregate—By inundation or by weight based on predetermined volumes.

There is still in force a specification on older contracts where fine aggregate is required to be measured as cast into the measuring box and struck, and in these contracts the proportion is fixed at 1:2:3.85 to compensate for the bulking of moist sand. It will be noted that the mix is very rich, a circumstance that will be referred to later.

Mixing—All mixers now in use are of the rotary type and vary in size from a one-bag batch to a seven-bag batch, except in one case at a central mixing plant, where a twenty-bag batch (3-yd.) mixer is used. The minimum mixing time is one minute for 1-yd. mixers and smaller, two minutes for the 3-yd. mixer. Portable mixers are located directly on the works; central mixing plants either on the site of the works or at a near-by convenient location.

Where portable mixers are used, the concrete is generally chuted directly from the mixer to the forms underneath; in the case of central mixing plants, concrete is hauled in motor trucks and deposited directly from the trucks to forms through chutes. In the case of one central mixing plant from which the haul is long, concrete is transported by motor trucks on which are mounted drums which revolve in transit to preserve workability. The hauling of concrete has necessitated regulation by rules, limiting the time between mixing and depositing. For large building construction (such as shops) towers and long chutes are sometimes used for conveying concrete. For lining rock and subaqueous tunnels the pneumatic method is frequently used, principally for roof arch concrete. In cold weather the usual precautions are taken, such as preheating the aggregates and the water and maintaining sufficiently high temperature in the concrete until it reaches a certain degree of hardness. The use of accelerators is not permitted and only in specially difficult work is an admixture (diatomaceous earth) allowed.

Many factors must be considered in determining the quality of concrete, and no one factor can safely be selected as sole criterion. However, if all the factors but one can be predetermined, that one may be selected as the criterion, which in this case is strength. The factors such as density, quality of ingredients, grading of aggregates and regulation of water, all tending to produce durability and good quality, have been taken care of by inspection, measuring, mixing and other precautions, leaving but strength to be determined. In these circumstances strength becomes a very good and accurate measure of the quality of concrete and a particularly valuable one for the needs of our rapid-transit construction, as it affords an excellent guide for the comparison of concretes made by different mixing plants and is readily understood by field engineers, contractors and inspectors. It is a requirement, however, not mentioned in the specifications.

Concrete tests are made on sets of nine 8x16-in. cylinder specimens molded at one sampling, for testing at 7, 28 and 90 days. The samples are taken either from the forms immediately after the deposition of concrete or as it is being deposited in the forms. The sampling crew also checks up the measuring devices and equipment of the mixing plant producing the concrete. At least one set of specimens every month is made for each mixing plant, but additional tests are sometimes made on an individual plant to correct irregularities.

A typical record of test is shown by Fig. 2, which is a combination of 7-, 28- and 90-day reports on a sample of concrete. These reports are furnished to the engineer in charge of the particular work, the division engineer and others interested. Any irregularities discovered in the operation of mixing plants or handling of concrete are reported immediately to the engineer in charge.

These tests, along with collateral tests and investigations of concrete in the laboratory, developed the factors contributing toward good concrete. They have been of great value in standardizing its manufacture and in producing concrete of more uniform quality on these extensive works, where improvement became apparent very shortly after their introduction, as the field engineers were furnished a definite measure of quality.

Specimen and Lot Strength

While strength is used as the criterion, the strength of concrete in specimen form does not represent the strength of the same concrete in the structure. In the

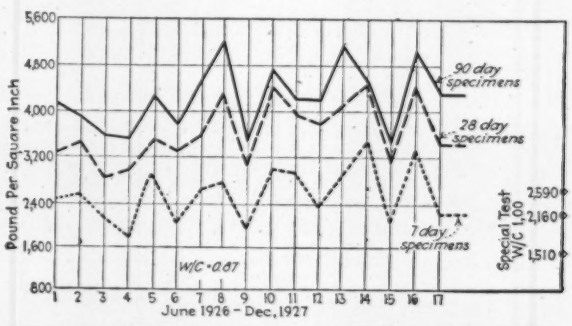


FIG. 5—AN EXAMPLE OF CONCRETE UNIFORMITY RESULTING FROM CAREFUL CONTROL

A 1½-yr. record on Section 1, Route 78. At the right of the diagram are shown the results of a special test made by increasing the water-cement ratio from 0.87 to 1.00. Note the lower strengths.

year 1914 concrete cut from the structure at the locations where the samples for the original test specimens had been taken was tested. Sixteen specimens cut from four different locations in the structure and tested at 90 days after placing showed an average strength of 2,670 lb. per sq.in., whereas a similar number of specimens cast in molds made from the same batches used in the structure gave an average strength of 2,110 lb. per sq.in. at 90 days. In the period 1914 to 1916 fifteen specimens cut from six different locations in the structure gave an average strength of 2,920 lb. per sq.in. (at twenty months), while the average strength of 90-day specimens cast in molds was 2,100 lb. per sq.in.

All this concrete, however, had been very wet, the sample specimens being made simply by pouring the concrete in the molds, care being taken to avoid all manipulation. While no specimens have been cut from the structure in recent years, it is the intention to do so for information, although it is recognized that there will not be developed a relative increase in strength as in earlier years, since much stiffer concrete is now made and in casting specimens the concrete is manipulated in the molds according to standard practice.

A Record of Improvement

This form of testing and control has been in operation fifteen years, beginning when it was the general practice to make very wet mixes. Fig. 3 shows graphically the progressive improvement in quality of subway concrete during this period. Hidden in this diagram is recorded an interesting history, as each increase in strength—representing improved quality—is the result of an individual attack on the problem.

In the year 1914 concrete in general produced by the many contractors was exceedingly wet and common practice was irregular, resulting in low strengths. Steps were taken in 1915 to reduce the amount of water used in mixtures and to improve methods of mixing and placing, with the result that an 11½ per cent increase in 28-day strength was effected in one year. Continued effort throughout this and the succeeding year (1916) resulted in still further improvement, represented by an increase in 1916 of 18 per cent over the 1914 strengths of 28-day specimens.

In the next year, 1917, not much progress was made, but no ground was lost. It had been noted that the measuring devices were many in kind and some of them obviously inaccurate, although of kinds in common use. During 1918 the calibration of devices for measuring fine and coarse aggregates was begun, and immediately there were disclosed wide discrepancies and consequently great variation in the unit volumes used at the many mixing plants. At one plant the actual proportion proved to be 1:2:5½, another 1:3:5, and at a third 1:1.7:3.8, whereas the specifications called for 1:2:4. The specifications in force in those days required the measuring of aggregates as cast loose in a measuring box. During this year measuring devices were more carefully controlled and concrete strengths rose rapidly, so that the average 28-day strength for the year became 2,400 lb., an increase of approximately 55 per cent over the 1914 period.

A hiatus now appears in the curves from 1919 to 1925, a period when comparatively little construction work was under way and when concrete testing was not continuous enough to yield averages that could be considered reliable. During this period, however, the study of concrete continued, including an experiment with a contractor's plant to determine the effect of exact measuring of ingredients, which led in 1921 to a modification of the specifications, requiring exact measuring devices for fine and coarse aggregates, and the measures struck. Testing in volume began again in 1926, a period when heavy construction was well under way, and the effect of the requirements for exact measuring is reflected in a strength increase of 66½ per cent over 1914.

In 1926 a vigorous campaign for the exact control of water began, the effect of which was a further improvement, illustrated by a strength increase at the present time of 89 per cent over the 1914 strengths.

The astounding feature of this record is the fact that

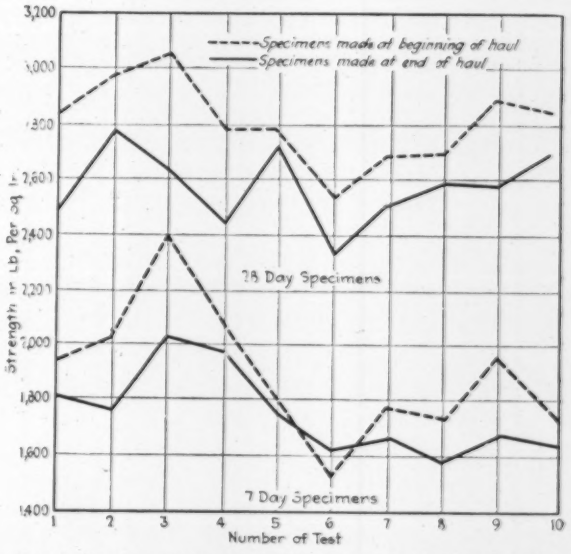


FIG. 6—THE EFFECT OF TIME OF HAUL ON STRENGTH OF CONCRETE

Based on tests of 8x16-in. cylinders made from samples taken from trucks immediately after mixing and again at at the end of the haul. Average time of haul was 65 minutes.

since 1914 the aggregates have been identical in kind, quality and grading; the specified proportions had been changed in a very minor degree for coarse aggregates in one instance only; the cement specifications are identical, and yet a decided improvement in concrete has been effected. In 1914 the general principles governing good concrete were fairly well known and promulgated. This record illustrates the difficulty in overcoming fixed custom and practice and the obstacles encountered in attempting reforms in advance of their time.

Cement Characteristics

In the period 1913 to 1927 inclusive seventeen brands of cement, totaling 8,600,000 bbl., were used; the maximum number of brands used in one year was thirteen and the minimum four. Fig. 4 shows graphically the results of certain laboratory tests on all the cements. Ordinarily the records of tensile tests are open to question on the ground of the personal equation, but in this instance the briquets were made by and under the supervision of one operator, only three others at times assisting during the entire period of fifteen years. The 28-day specimens were selected as most representative. The curves have value only in illustrating the relation between strengths of cement year by year and, as is well known, are not directly comparable with tests made

by other laboratories. The points on the curves representing strength are weighted averages for each year, based on the number of briquets tested and their corresponding strengths. The points on the fineness and lime factor curves are the weighted averages for each year, based on the number of bins tested and their corresponding fineness or lime factors, as the case may be.

With the adoption of the standard specifications for portland cement several years ago, requiring finer grinding, and with the increase in lime, the improvement in process, better control of the raw material and improved equipment, there would naturally be expected an appreciable increase in strength. This is not uniformly reflected, however, in tensile tests, as the mortar specimens show an increase in strength, while the neat specimens do not. A comparison of the strength curves on the diagram with the concrete strengths does not indicate a direct relation between them, the reason being that the factors affecting strength in concrete outweigh appreciable differences in strength in the cement. On works where the best control of concrete manufacture was exercised during the period of increase in strength of mortar briquets the concrete tests show uniformity in strength throughout the life of the work, indicating the overshadowing effect of normal variations in concrete manufacture. There is no doubt, however, that the

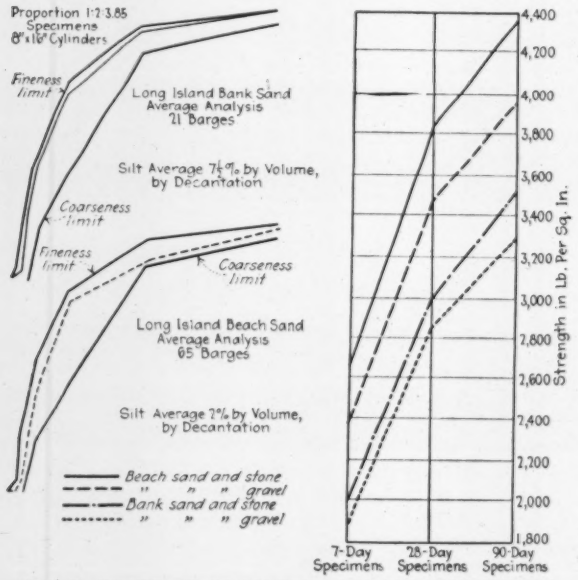


FIG. 7—TESTS OF CONCRETE SHOWING INFLUENCE OF TYPE OF SAND ON STRENGTH

See Fig. 1 for fineness and coarseness limits.

strength of cement is a most important factor in concrete strengths, and where other things are equal, the stronger cement will produce stronger concrete.

An Example of Water Control

Fig. 5 shows what may be accomplished in the production of uniformly good concrete. It is the record of a single piece of subway work extending over a period of 1½ years under the supervision of an able engineer. The accompanying table gives the averages of this job compared with the year's total average on all jobs. The materials used were the standard specification materials used by many other contractors. The factors contributing toward uniformly strong, dense concrete were a portable mixing plant which operated an average of 1½ minutes for each mix and deposited the concrete directly from the mixer to the forms; and in addition excellent control of water, resulting in uniformly low water-cement ratio. The case is cited as an example of what can be accomplished steadily day after day, inspiring hope and confidence that all concrete will eventually be made equally good; a number of other sections produce concrete of equal quality and still others nearly as good. During the progress of this particular piece of work it was contended that the brand of cement was responsible for the strengths developed, although experience in testing indicated it was solely water control. A special test was made at the plant by increasing the amount of water to produce a water-cement ratio of 1, with the result as shown in the vertical line to the right of the diagram, proving conclusively that where other things are equal, the water-cement ratio is the controlling factor.

COMPARISON OF THE CONCRETE STRENGTHS OF FIG. 5 WITH THE YEARLY AVERAGE OF ALL JOBS

Age of Specimens	Average Strength of All Specimens Made on All Routes and Sections in 1927 Lb. Per Sq. In.	Average Strength of Specimens Route 78—Section 1, Lb. Per Sq. In. $W/C = 0.87$	$W/C = 1.00$ (for special test)
90 days	3,300	4,240	2,590
28 days	2,800	3,720	2,160
7 days	1,750	2,580	1,510

In speaking of proportions and water-cement ratios it should be kept in mind that the units of volume are different from those generally adopted as standard, consequently the water-cement ratios are different, and these two are not directly comparable with the generally accepted values of these terms. For instance, one bag of cement is generally considered 1 cu.ft. in volume, and the proportion of 1 : 2 : 4 converted to that unit of volume would make subway specifications read, 1 : 1.75 : 3.50. The water-cement ratio of 1, if converted to the accepted standard, would be 0.875.

Agitation in Transit

From time to time new conditions arise requiring special investigation, as, for instance, the question of the effect of length of haul on concrete. Fig. 6 shows the results to date of an investigation which is not yet complete but which has already yielded sufficient data to indicate the effect of length of haul on mixed concrete. This concrete is transported in revolving drums mounted on motor trucks, and it was claimed that the concrete was not affected by a haul of even an hour's duration. The average time of haul was 55 minutes, and the tests indicate that concrete loses 10 per cent in strength for this length of haul. The material delivered in every case was in excellent workable condition.

Influence of Load

Research has been so extensive and has developed so much information, particularly regarding some of the factors which have controlling influence on the properties of concrete, that some of these factors have been seized upon by engineers and manufacturers of concrete without due regard to related influences. We find, therefore, propaganda for strength, workability, density, water-cement ratio, or fineness modulus, etc., as a sole guide which by ignorant application may produce anything but good concrete. One cannot afford to overlook any factor having an influence on the product.

As an instance in point, an analysis of tests on these works over a period of two years on concrete containing

various aggregates indicates very clearly that the type of fine aggregate may have a decided influence on the strength of concrete. Among the sands used extensively are two from Long Island, each very uniform in character and quality year after year. The principal difference between the two is in grading and silt content. One is excavated from banks inshore and washed, referred to as bank sand, and the other is dredged from the beach along the Sound, referred to as beach sand.

Fig. 7 shows the typical analysis curves of both sands. The bank sand carries 7½ per cent of mineral silt by volume determined by decantation and the beach sand 2 per cent. The sketch shows the results of tests on concrete containing these sands. They represent concrete as made on a number of works and are arranged according to the combination of the fine and coarse aggregates. The beach sand at every period, when in combination either with gravel or broken stone, yields greater strength than bank sand with the same coarse aggregate. One might be inclined to accept these results as convincing proof that beach sand was the controlling factor governing the strength of concrete, whereas other influences were at work and the sand alone may not be the explanation. Had all the other factors influencing strength been equal, the type of sand would have been the controlling influence or factor. This is a further illustration of the hazard of predicating results on any single factor affecting the quality of concrete.

The expedients adopted for economy in the production of concrete are sometimes misleading though persuasive, as, for example, the fixing of strength as a major requirement. Specifications frequently require that the concrete shall develop a minimum strength of 2,000 at 28 days, on the theory that since this strength meets the requirements of design, economy may be effected by saving material and avoiding much greater strength. All this saving must be at the expense of cement. For subway concrete, let us see what the saving may be and then inquire if it be economy. The contractors' average price for concrete is $20 per cubic yard; of this, the materials delivered to the site cost $7.50, half of which is for cement, and the remaining $12.50 covers labor, forms, profit and contingencies. It would appear that the average saving on cement per yard of concrete might be about 50 or 60 cents. With the above-mentioned prices and costs, it is doubtful, to say the least, that a contractor can figure so closely as to effect a saving to his client of 50 cents per yard, and when and if the saving is effected, what is the result? The client pays $19.50 for $13 concrete, whereas if he disregarded the attempt at a problematical saving he would receive $20 concrete for $20. In other words, to effect a hypothetical saving of 2½ per cent he purchases 2,000-lb. concrete instead of 3,000-lb. concrete.

Typhoid and General Death Rate Low in 1927

Typhoid fever deaths in the registration area of the United States totaled 5,980 in 1927, against 6,826 in 1926, according to figures announced by the Department of Commerce. The registration area in 1927 included 42 states, the District of Columbia and 22 cities in non-registration states, having a total population of 108,327,000, or 91.3 per cent of the population of the United States. The total death rates per 1,000 for the two years were 11.4 for 1927 and 12.2 for 1926. Automobile accidents, other than collisions with trains and street cars, caused 21,160 deaths in 1927, against 18,781 in 1926.

Weld Test of Heavy Column Joints Shows Good Results

Joints Which Will Be Riveted in Towers of Hudson River Bridge Show 11,500 Lb. Per Inch of Fillet When Welded

FOLLOWING a series of tests it made for the Port of New York Authority on values of rivets and bolts in tension on typical joints to be used in the Hudson River suspension bridge, the American Bridge Company on its own initiative straightened and welded the specimens and retested them under the same conditions as used in the original tests. The results furnish excellent data on the strength of long fillet welds (two 46-in. fillets) in transverse shear.

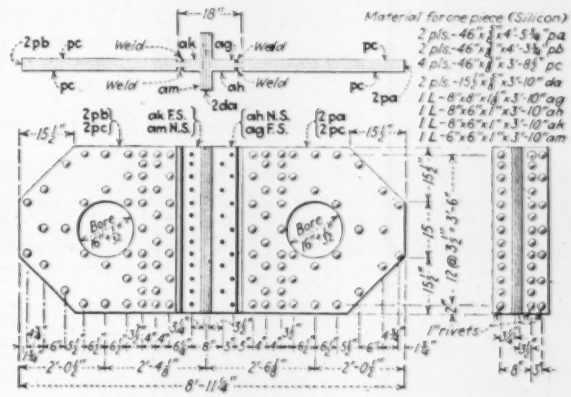


FIG. 1—WELDED TEST PIECE TYPICAL OF THE HEAVY COLUMN JOINTS WHICH WILL BE RIVETED IN THE HUDSON RIVER BRIDGE TOWERS

The test specimen shown in Fig. 1, except for welding, represents a typical column joint to be used in the tow-

FIG. 2—WELD FRACTURE AT 11,680 LB. PER LINEAR INCH

ers of the Hudson River bridge. The original tests made with the specimens completely riveted showed a maximum load of 950,000 lb., or 46,520 lb. per sq.in. of nominal rivet section. After these tests the distorted angles of the original specimens were straightened and the specimens fabricated as shown in Fig. 2. A fillet

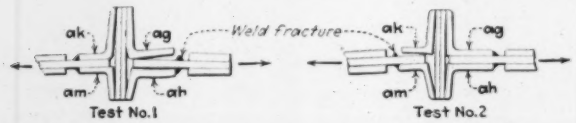


FIG. 3—METHOD OF FAILURE OF WELDED JOINTS
Weld fracture occurred in plane perpendicular to fillet face. Note bending in angles.

bead $\frac{7}{16}$x$\frac{1}{2}$ in. was deposited in two layers, using $\frac{5}{32}$-in. electrodes with 175 amp. for the first layer and $\frac{3}{16}$-in. electrodes with 205 amp. for the second layer.

The specimens after testing in a 2,000-ton eyebar testing machine are shown in Fig. 3. The test results were as follows:

Test No. 1—Maximum load, 1,100,000 lb.; broke in weld, along *ag;* average width of weld fracture, 0.453 in.; total linear inches effective weld, 92; stress per linear inch weld, 11,950 lb.; stress per square inch weld, 26,380 lb.

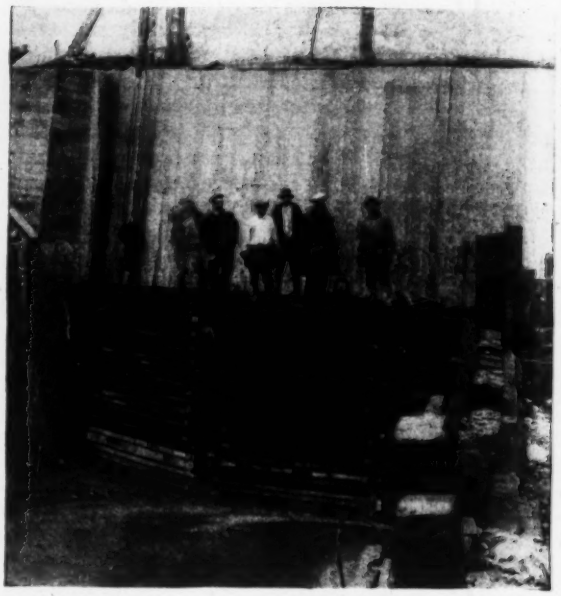
Test No. 2—Maximum load, 1,075,000 lb.; broke in weld, along *ak;* average width of weld fracture, 0.416; total linear inches effective weld, 92 in.; stress per linear inch weld, 11,680 lb.; stress per square inch weld, 28,090 lb. per sq.in.

Weighted Gate Closes Opening in Multiple-Dome Dam

Coolidge Dam Closure Provides for Taking Up Plug Shrinkage—Agitation and Vent Pipes Avoid Trapping Air

CLOSURE of the Coolidge multiple-dome dam in Arizona was effected by lowering a weighted timber gate in front of the opening in one of the domes through which streamflow passed during construction. A watertight membrane and drains placed behind this gate after it was seated made it possible to fill the opening with concrete placed in the dry. By an arrangement for finishing with grout under pressure, described in the following, even the cracks left by shrinkage of the concrete plug were filled. Announcement of closure and the beginning of storage was published in *Engineering News-Record,* Nov. 29, 1928, p. 820, and a description of the dam itself appeared in the issue of Sept. 20, 1928, p. 438.

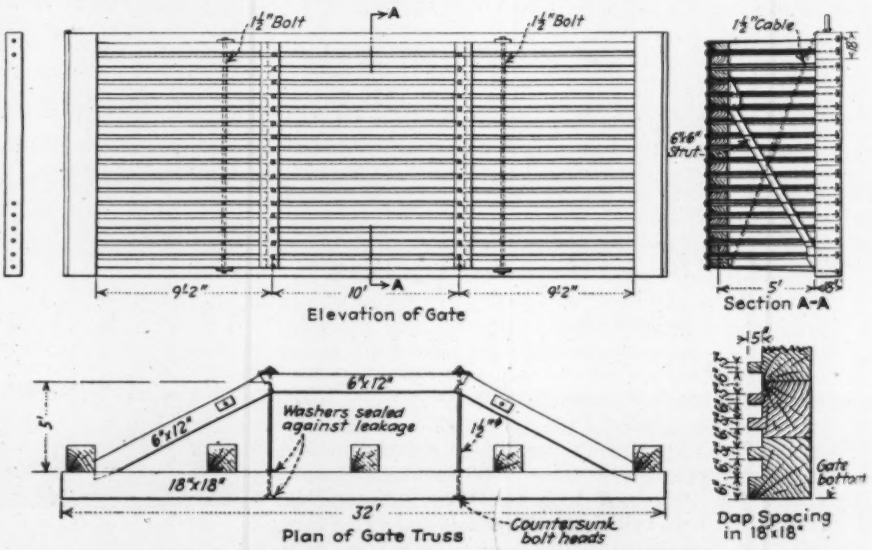
The general scheme of closure was worked out before construction began;



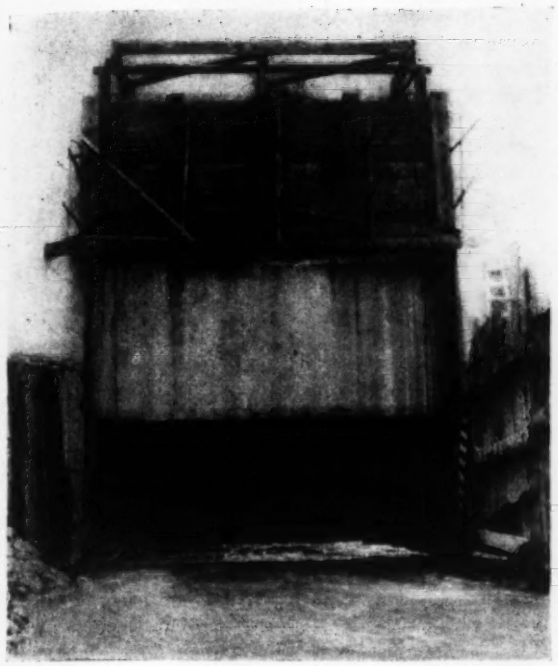
UPSTREAM SIDE OF THE GATE SHORTLY AFTER CLOSURE
Lowering cables still in place on one side. Note bolts of queen post trusses.

therefore the grooves, guides and keyways shown in the accompanying illustrations were built in place as part of the dam as originally constructed. As time for the closure approached a timber structure was erected above the gateway consisting of a vertical mat of 18x18-in. Douglas fir timbers stiffened and strengthened by queen post trusses placed in horizontal planes. By making these trusses of 6x12-in. timbers it was possible to use two trusses for each of the 18x18-in. timbers. The space thus formed within the truss members was lined with planks and filled with stones. As finally assembled, ready for dropping into place, the total weight of the gate was estimated to be 37 tons.

At the time of closure the streamflow through the opening was only 170 sec.-ft. However, during the construction period the streamflow has been as high as 6,700 sec.-ft. The gate was designed with a view to



TIMBER CRIB GATE USED IN EFFECTING CLOSURE



STREAMFLOW PASSING THROUGH THE DOME NEAR LEFT BANK

The mat for the timber gate has been assembled above the guides, but the timber trusses have not yet been put in place.

making closure sure under any quantity of streamflow up to 2,000 sec.-ft.

When all was in readiness for closure the gate was suspended by cable tackle from I-beam brackets built into the concrete dome above the opening; the suspending tackle consisted of two sets of three-sheave, 18-in. blocks rove with ¾-in. cable. The hauling parts from each tackle led to a 1½-in. hauling line from the overhead cable. A clearance of 3 in. was allowed at each end of the gate in order to prevent binding and to allow an even seat of the gate on the sill. Operation of this equipment was tested repeatedly before actual closure was made, and when the time came to stop the flow the gate was slid into place without interference of any sort.

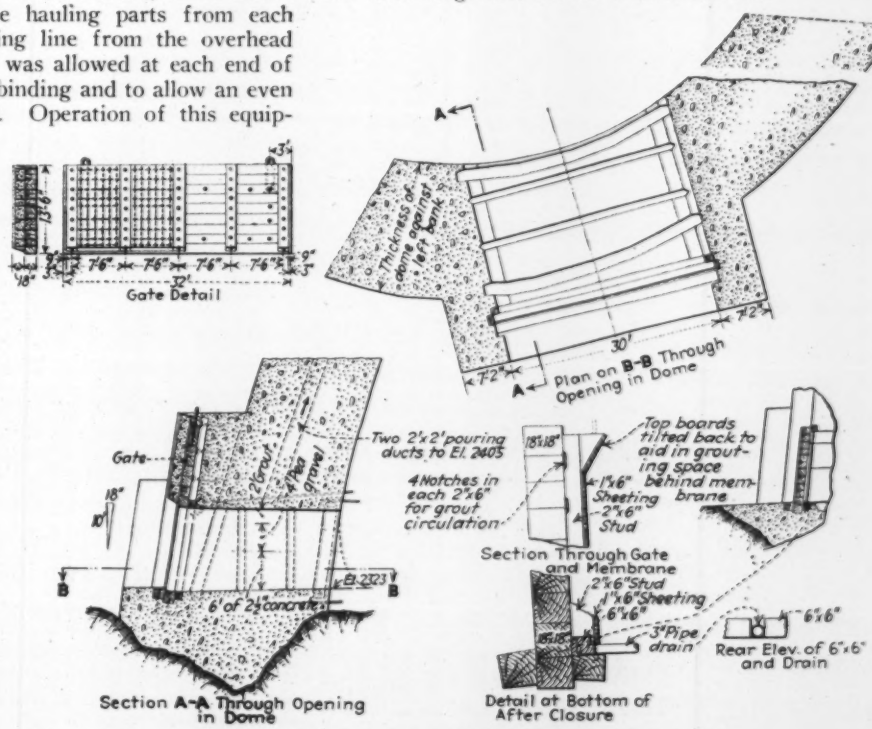
The seat on which the gate was to rest had been prepared by embedding 18x18- and 12x12-in. timbers in the concrete in the bottom of the opening and as soon as the gate was seated 6x6-in. timbers were spiked into place behind it, as shown in the illustrations. On the rear face of the gate 2x6-in. vertical studs were then placed and a sheathing of tar paper and boards was put over the studs to form a watertight membrane that would hold any leakage that came through the gate. This leakage was collected at the base of the membrane and conveyed to the downstream side of the dome by six 3-in. pipes. Side walls, roof and floor of the opening through the dome were then chipped with air hammers and the grout system in the keyways installed.

The concrete plug itself was deposited in a series of pours delivered through two 2x2-ft. chutes or cored-out openings leading upward to a point on the extrados of the dome 130 ft. above. The first pour, 6 ft. deep, was made with concrete in which 1½-in. rock was used. This was followed by a 4-ft. layer in which only pea gravel was used, and the final or closing layer, 2 ft. thick, consisted of a cement and sand grout, using twelve sacks of cement per cubic yard. In this third pour the last of the grout was placed under a pressure head of 14 ft. in the pouring holes, in order to effect a tight seal against the roof. In this pour trapped air was vented through 3-in. pipes that extended up through the dome to an outlet about 40 ft. above the gate.

For three hours after this pour had been completed the concrete in the pouring holes was agitated by weights attached to ropes passing up through the pouring holes. At the end of this period grout was again added in the pouring holes until surplus water, scum, etc., was ejected through the air vent pipes already mentioned. Finally, on the day following, the 2x2-ft. pouring holes were filled to the surface of the dome.

Ten days after these concreting operations had been finished, grout was forced in under pressure through the grouting system and the drainage pipes were filled. Careful inspection for leakage showed the plug to be tight, slight dampness occurring at one spot only.

The method of closure was devised and the closure itself supervised by J. G. Tripp, superintendent for Atkinson, Kier Brothers & Spicer, contractors on the dam, under the general direction of C. R. Olberg, assistant chief engineer, U. S. Indian Service.


Gate Detail
Thickness of dome against left bank
30'
7'2"
Plan on B-B Through Opening in Dome
Gate
Two 2'x2' pouring ducts to El. 2405
4 Notches in each 2"x6" for grout circulation
Top boards tilted back to aid in grouting space behind membrane
1"x6" Sheeting
2"x6" Stud
Section Through Gate and Membrane
2"x6" Stud
1"x6" Sheeting
6"x6"
3" Pipe drain
6"x6"
Rear Elev. of 6"x6" and Drain
6' of 2½ concrete
Section A-A Through Opening in Dome
Detail at Bottom of After Closure

DETAILS OF STREAMFLOW OPENING, COOLIDGE DAM

Rolled-Fill Earth Dam Constructed Without Shrinkage

Selected Soil With Regulation of Moisture and Compaction With Sheep's-Foot Tractors Eliminate Settlement

By F. A. Lammiman
Chico, Calif.

PRACTICALLY no settlement or shrinkage in eighteen months is the record of a rolled-earthfill dam built in 1926 on Philbrook Creek in northern California for the Pacific Gas & Electric Company. The dam had a crown of 12 ft., an upstream slope of 1 on 2½ and a downstream slope of 1 on 2. The length was 900 ft. and the height above streambed 85 ft. The site was a terminal moraine through which the creek had cut a deep channel. Heavy stripping was necessary to remove all vegetable-bearing soil as well as loose material and water-bearing sand and gravel. Along the core trench it was necessary in places to excavate as much as 20 ft. to get below porous lenses of sand and gravel.

The specifications called for selected material in the core trench and the upstream third of the cross-section. In practical application this resolved itself into selection of a fairly impervious clay for the filling of the core trench and a thorough mixing and distributing of all other materials throughout the rest of the section. It was required that the material be spread in 4-in. layers and that each layer be thoroughly tamped before spreading another layer. Tractors having their driving wheels studded with sheep's-foot tampers were used in place of rollers. Each tractor had a tamping capacity of approximately 25 cu.yd. per hour.

The fill, taken from the floor of the valley above the dam site, consisted of clay, sand and gravel in lenses 1 to 2 ft. thick. As the pits were deepened, groundwater was encountered. Extreme care was required to avoid getting the material into the dam in a condition too wet for thorough compaction. It was necessary to bring material from different parts of the pit in rotation, thus putting down first a layer of moist clay followed by one of dry sand or gravel, or vice versa, the tamping machinery mixing as well as compacting. By following this order continuously the whole mass was brought to a consistency very similar to that of a waterbound macadam road with a slight excess of clay filler. The completed fill totaled 142,000 cu.yd., and the borrowpits measured 169,000 cu.yd., showing a shrinkage under tamping of about 16 per cent.

Before water was impounded five iron rods, each 5 ft. long, were driven full length into the back slope. Four were near the crest elevation and one was part way down the back slope. Careful levels referred to a permanent benchmark were run over these rods. The reservoir was filled during the winter of 1927, emptied during the summer and filled again in 1928. On May 23, 1928, levels were again run over the rods; the following are the comparative elevations:

	No. 1	No. 2	No. 3	No. 4	No. 5
November, 1926	5,422.32	5,422.08	5,422.33	5,422.11	5,383.27
May, 1928	5,422.29	5,422.03	5,422.35	5,422.15	5,383.37
Difference	—0.03	—0.05	+0.02	+0.04	+0.10

As far as could be determined, actual settlement was very close to zero. No seepage whatever is apparent through the fill, but about 0.8 sec.-ft. passes under the fill through the foundation material.

This dam was built by the Kaiser Paving Company, contractor, Oakland, Calif., under the direction of O. W. Peterson, chief engineer of construction for the Pacific Gas & Electric Company, with the writer as resident engineer.

Some Recent Points Decided in Engineering Law

Reviewed by Herbert Braasch
Attorney at Law

Decisions reached in cases tried in the higher federal courts and in the state supreme courts are summarized in these articles appearing from time to time in *Engineering News-Record*. The last group will be found in the issue of July 19, 1928, p. 96.—Editor.

Owner's Free Use Favored

A builder began construction of an apartment house in a restricted residential district, the deed providing for residential use only, with a single residence or dwelling house on a lot. Injunction proceedings to stop him were dismissed.

In construing restrictions as to the use of property, doubts will be resolved in favor of free and unrestricted use by the owner. The restriction is aimed at the use, not the architectural design, and a building occupied by a number of families is no less a dwelling house than one occupied by a single family. It is a single structure intended for residential purposes only.—*Charlotte Consolidated Construction Company vs. Cobb, North Carolina.*

Non-Recoverable "Safety" Expenses

The wall of a building collapsed when excavation was made for an adjoining structure. The damaged owners sought to recover from the contractor conducting the operation. Relief was denied. The contractor's duty was to furnish only such support as the earth would need free from the lateral pressure of improperly constructed foundations. Since this contractor had no duty to supply shoring, struts or other bracing, he could not have recovered their cost had he supplied them to safeguard the adjacent building. In giving notice that he intended to begin excavation and that the foundations were in need of attention, and in allowing access to make repairs, the contractor fulfilled all obligations.—*Neyman vs. Pincus, Montana.*

City Liable on Faulty Water Supply Project

A stave line running along a mountainside conveyed water to the city of Ogden, Utah. Because of its age and leaky condition, part of the mountainside was softened, causing several landslides during heavy rains. The slides threw up a barrier across a stream in the canyon below, the resulting flood injuring cottages of landowners. The court held that the one maintaining such faulty flume was liable.

The city then claimed that it was exempt from liability because it was engaging in a governmental function. The court held that furnishing water to private citizens was the exercise of a proprietary function, not a governmental one, and in such an undertaking the city was liable.—*Egelhoff vs. Ogden City, Utah.*

Data of a Cloudburst Flood in Rondout Creek

Rainfall and Discharge Figures for Flood of Last August—Highest Discharge in Upper Course

By E. A. Van Deusen
Hydraulic Engineer,
Central Hudson Gas & Electric Corporation,
Poughkeepsie, N. Y.

On Aug. 26 and 27, 1928, a phenomenal flood occurred in the Rondout Creek valley, N. Y., as the result of a "cloudburst" in the upper valley during the afternoon. An abnormal amount of rain had fallen through the months of June, July and August, so that the ground was fairly well saturated and the ground-water level was high, circumstances particularly favorable to flood conditions in the event of a heavy rainstorm. Fig. 1 herewith is a map showing the location of Rondout Creek and adjacent streams, the extent of its drainage area, the location of the rainfall stations and of two stream gaging stations.

August Rainfall Figures—The rainfall on Aug. 25 and 26 at various points, the amount that fell during the month prior to these dates and the total rainfall for the month, were as follows:

	Aug. 25	Aug. 26	Amount Prior to Aug. 25	Total, Aug.
Grahamsville*	0.78	6.81	7.16 in 12 days	15.53
Sundown*	0.70	6.26	6.26 in 11 days	14.29
Peekamoose*	0.91	5.71	6.37 in 11 days	14.34
Lackawack*	0.60	4.68	4.74 in 13 days	10.40
Honk Falls	0.45	2.81†	4.35 in 11 days	9.05
High Falls	0.71	2.95	6.23 in 13 days	10.65
Mohonk	0.72	2.35	5.24 in 8 days	9.72
Pine Bush	0.15	2.05	2.79 in 8 days	5.51
East Walden	0.55	0.85	5.75 in 12 days	9.41
Dashville	0.85	2.20	4.70 in 11 days	8.42

*N. Y. Board of Water Supply. †Incomplete—gage flooded out.

It will be observed that the heaviest precipitation occurred in the upper Rondout drainage area, and that rain was general not only over the entire Rondout basin but also over the Wallkill basin, despite the high Shawangunk divide between.

Rondout Creek rises in the timber-covered mountain group forming the Wittenberg chain of the Catskill Mountains, at an elevation well over 2,000 ft. It flows southeastward to Napanoch, where it meets the Shawangunk range, turns abruptly to the northeast and enters the Hudson at Kingston. Notable falls occur at Honk Falls, Napanoch and High Falls. The total area drained at the point where it joins the Wallkill River is 390 square miles.

Although the effects of the flood were felt for the entire length of the stream, even to its point of discharge into the Hudson River at Kingston, its greatest intensity was experienced in the upper reaches above Napanoch and Honk Falls. For instance, at Rosendale, with a drainage area of 380 square miles, the peak discharge was 27,400 sec.-ft., whereas at Honk Falls, with a drainage area of only 102 square miles, the discharge was approximately 30,000 sec.-ft. This difference is accounted for by the fact that the "cloudburst" was in the upper valley and also that between these two points large areas of flood plains were inundated to a depth of several feet and acted as a series of retarding basins.

Above Honk Falls there was a stream-gaging station operated by the New York Board of Water Supply. Unfortunately this, together with the bridge to which it was attached, was destroyed by the flood so that no instrumental record of the flood stage at this point was obtained. In an attempt to determine approximately the flood flow the writer spent some time at various points along the stream examining and measuring high-water marks.

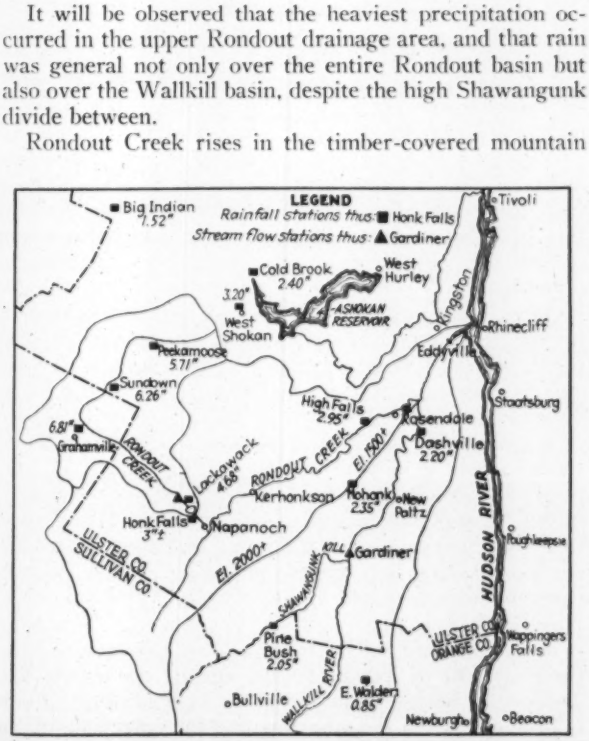


FIG. 1—RAINFALL OF AUG. 26

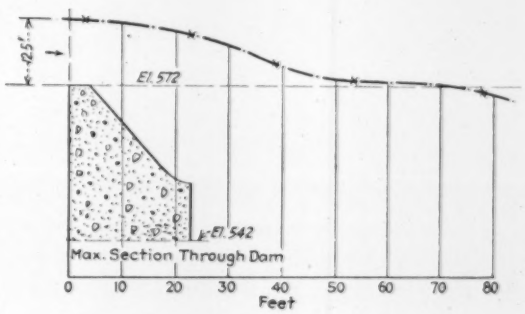


FIG. 2—PEAK FLOW AT HONK FALLS DAM

TABLE OF FLOOD DISCHARGES AT VARIOUS POINTS

		Flood Discharge, Sec.-Ft.	Drainage Area, Sq. Mi.	Discharge Per Sq. Mi., Sec.-Ft.
Rondout Creek	Honk Falls*	30,680	102	300
	Rosendale†	27,400	380	72
Wallkill River, Gardiner†		9,340	716	13
Rondout Creek plus Wallkill River	Gardiner† and Rosendale†	36,740	1,096	33.5
	Eddyville*	38,000	1,185	32

*Discharge over dam computed by Francis formula for sharp-created weirs.
†Stream gaging stations with automatic seven day water-stage registers.
Note:—Streamflow records on Rondont Creek at Honk Falls (Lackawack) with 100 square miles drainage area have been kept since 1906. During this period the maximum flow recorded was 5,832 sec.-ft. (58.3 sec.-ft. per square mile), on March 27, 1913. Several flows of 50 sec.-ft. per square mile have occurred during the past twenty years. Figures are from records kept by the New York Board of Water Supply.

Extreme Flood in Upper Course—At the Honk Falls dam careful measurements by foot-rule and Locke level indicated a depth of water of 12.5 ft. over the crest of the spillway. High-water measurements downstream from the dam showed the crest to have been submerged for a distance of about 70 ft. downstream (Fig. 2);

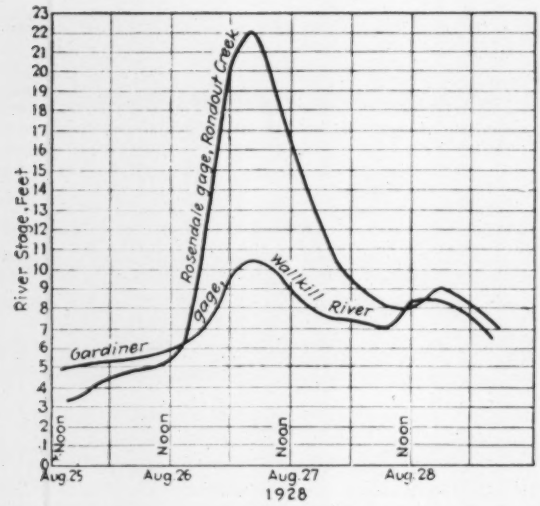


FIG. 3—HYDROGRAPHS OF RONDOUT AND WALLKILL

beyond this point the water surface dropped rapidly down the Honk Falls gorge. In calculating the probable flood discharge this crest submergence was ignored, as it was believed that the dam operated as a non-submerged sharp-crested weir. A velocity of approach of 8 ft. per second was assumed, and the resulting discharge was calculated to be 30,680 sec.-ft., or 30,680 ÷ 102 = 300 sec.-ft. per square mile.

Kuichling's curve for flood flows indicates that for a drainage area of 100 square miles of flow of 300 sec.-ft. per square mile is a "flood which may occur rarely." It is hoped that Kuichling is right!

Similar measurements were made on an old mill dam at Eddyville, below the confluence of the Wallkill and the Rondout, where the drainage area is 1,185 square miles. On this dam the flood reached a height of 11.5 ft., as indicated by high-water marks, and the resulting discharge was calculated to be 38,000 sec.-ft., or 32 sec.-ft. per square mile. This figure checks approximately with readings from two stream-gaging stations, one at Gardiner on the Wallkill, and the other at Rosendale on the Rondout.

The Gardiner gage showed a stage of 10.4 ft., with a corresponding flow of 9,340 sec.-ft. for a drainage area of 716 square miles, while the Rosendale gage showed a stage of 21.9 ft., with a corresponding flow of 27,400 sec.-ft. for a drainage area of 380 square miles. The total of these two is 36,740 sec.-ft. for a total drainage

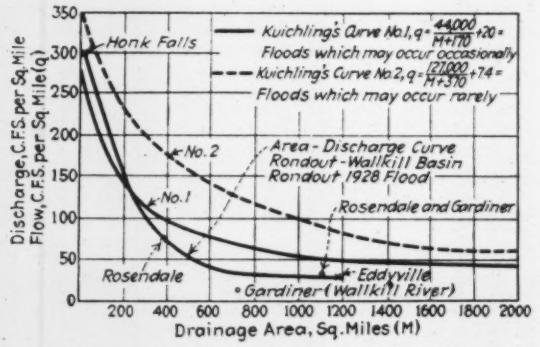

Discharge, C.F.S. per Sq. Mile
Flow, C.F.S. per Sq. Mile (q)
Honk Falls
Kuichling's Curve No. 1, q = 44,000/(M+170) + 20 =
Floods which may occur occasionally
Kuichling's Curve No. 2, q = 121,000/(M+370) + 7.4 =
Floods which may occur rarely
Area - Discharge Curve
Rondout - Wallkill Basin
Rondout 1928 Flood
No. 2
No. 1
Rosendale and Gardiner
Rosendale
Eddyville
Gardiner (Wallkill River)
Drainage Area, Sq. Miles (M)

FIG. 4—KUICHLING'S CURVES, AND DISCHARGE FIGURES OF RONDOUT FLOOD

area of 1,096 square miles, or 33.5 sec.-ft. per square mile, as compared with 38,000 for 1,185 square miles at Eddyville, or 32 sec.-ft. per square mile. It is assumed from this that the assumptions made for discharge over the two dams are not greatly in error.

It is of interest to note that the Wallkill River also felt the effect of the heavy general rains of Aug. 25 and 26, and furthermore that the peak stage of both streams registered closely the same time at both gaging stations—namely, 4 a.m., Aug. 27. The two stations are about 12 miles apart.

English Railways Try Steel Ties

Two New Designs Are Shallow Troughs—One Has Rail Supports Cast Upon It—Few Parts but No Insulation

A RECENT sudden revival of interest in steel ties by three of the four English trunk-line railways appears to be due largely to a movement for assisting the steel industry, which is suffering severely from lack of business. Longer life and ultimate economy in annual cost per tie (due to the increasing cost of wood ties) are suggested as advantages, but these are entirely problematical. The normal track construction employs creosoted pine ties 5x10 in. and 8½ ft. long, which are said to have a life ranging from fifteen to twenty years in main track. They are all imported, and the idea is that the railways would spend some of the money for domestic steel ties instead of foreign wood ties.

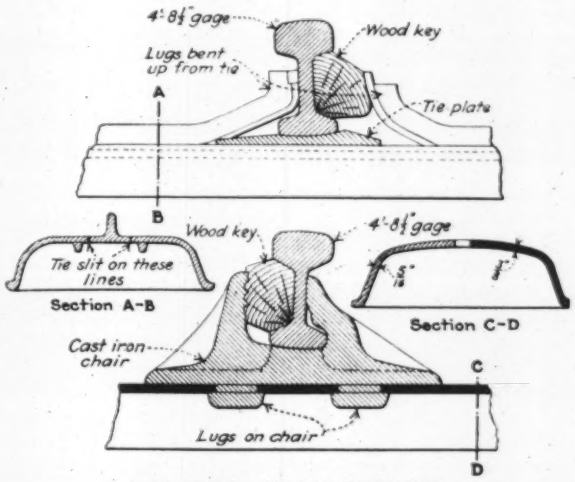
Steel ties of various kinds have been tried in England for many years, but generally in small experimental lots. An exception is that 45 years ago one road made at its own shops about 100,000 of the Webb ties, invented by its chief engineer. All of these designs were for the English type of bull-head rail, requiring heavy cast-iron chairs to carry them, except that the Webb ties had riveted steel-plate chairs. All are now obsolete. In general, the results were unsatisfactory both as to efficiency and economy. For the newer designs, railway engineers are reported as being rather more optimistic, but the published descriptions do not indicate much additional strength, while owing to the increased weights and wheel loads of modern equipment the earlier experiments do not afford much basis for estimating results. Insulation of track circuits is evidently not a factor in these present designs, which are shown in the accompanying drawing.

After about seven years' trial of the Sandberg steel tie, the Southern Railway has given an order for 70,000, which will be laid during the next two years, and with the wide spacing of English ties will suffice for about 35 miles of track. This tie is an inverted trough, stiffened by two small ribs inside and a high rib along the top. But it is weakened by slotting the top in four places and bending up the loosened portions, somewhat in the shape of rail braces, to take the place of the usual cast-iron chairs. This cutting and bending of steel ties carrying T-rails has been found objectionable on railways in India, as noted in *Engineering News-Record* of Nov. 1, 1928, p. 651.

Each bull-head rail rests on a loose tie-plate and has the inner side of its web resting against one of the bent lugs or rail braces, while a wooden wedge, termed a key, is driven between the other lug and the outer side of the rail web. Thus the rail fastenings consist only of two

wooden keys, and with the tie-plates there are only four loose parts to each tie. The ties are 8 ft. long, 11¼ in. wide and 2½ in. deep in the trough, with a 1 1/16-in. rib on top. Their weight is given as 142 lb., or 158 lb. with the tie-plates.

A composite steel and cast-iron tie that is being tried on a small scale by the Great Western Railway and the London, Midland & Scottish Railway consists of a



NEW STEEL TIES IN ENGLAND
Above, Southern Railway. Below, Great Western Railway.

pressed steel trough with two ordinary rail-chairs cast in place upon it and secured by lugs, the molten metal flowing through holes in the top of the tie. The method of casting is not explained, but would seem to be somewhat complicated in the adjustment of molds to each tie. In this case the two wooden keys securing the rails in the chairs are the only fastenings and loose parts. The trough is 8 ft. long, 11 in. wide and 3½ in. deep, weighing 144 lb., or 234 lb. with the two chairs.

A review of substitute ties on American railroads was given in *Engineering News-Record*, Feb. 28, 1929, p. 345.

Campaign to Make Sewers a Utility Continued at Grand Rapids

THE campaign to operate a sewerage system at Grand Rapids, Mich., as a utility, so far as charging for the use of the sewer is concerned, is being continued despite the lack of the required statutory three-fifths favorable vote on the proposal at the election on Nov. 6, 1928. The vote was taken under permissive state legislation enacted in 1927 following agitation begun as early as 1919. The statute authorizes cities subject to local charter requirements to finance and operate sewerage and sewage-disposal systems as utilities.

After study by the Grand Rapids Utilities Department and approval by the City Commission, two questions were put on the ballot Nov. 6 necessary to make the state legislation available for use in Grand Rapids. The first of these was merely on adopting the plan and resulted in a vote of 14,337 for to 12,271 against the plan, or a majority of 2,066. As only an actual majority was required for the acceptance of the state legislation as an amendment to the city charter, this proposal carried. The second vote was required to make the charter amendment effective. The proposal on the ballot for this purpose read: "Shall the city of Grand Rapids establish, operate and maintain its sewage-disposal plant and system on a utility basis, charging therefor in proportion to the service rendered?" The vote on this proposal was 14,723 for to 14,215 against, giving an actual majority of 508, or 2,640 votes less than the required three-fifths vote in favor of the plan.

In continuation of the educational campaign for the adoption of the plan in question there was carried on the bulletin board in the City Hall at Grand Rapids from Dec. 17, 1928, to Jan. 5, 1929, a group of eleven posters. Four of these showed a schedule of rates charged by the local street railway, electric light and power, gas, and telephone utilities. A fifth poster gave the same information for the city-owned water-works, and a sixth for the "proposed city sewage utility." Other posters in the group were designed to support the general principle set forth in the title poster: "The City Utilities Department Negotiates Rates Fair to the Public, Insuring Good, Economical and Continuous Service Through the Proper Co-ordination of the Following Fundamentals." The fundamentals were fair value of the property, a fair rate of return on the same, allowance for taxes, operating expenses and depreciation.

The poster headed "Rate of Return" stated that this should be "determined by taking into consideration money rates, financial requirements of the property, present and future obligations, and quality of service rendered." Each of the six utility posters bore one or more photographs illustrative of service rendered by the utility. The "tentative sewage rates" and the "sewage utility" posters were in seven steps, beginning at 5c. for the first 2,200 cu.ft., followed by 4½c. for the next 7,800 cu.ft., 4c. for the next 10,000 cu.ft., 3½c. for the next 30,000 cu.ft., 3c. for the next 50,000 cu.ft., 2½c. for the next 100,000 cu.ft., and 2c. for all over 200,000 cu.ft. used per quarter. In addition the schedule provides for a quarterly service charge ranging from $1.50 where ⅝- or ¾-in. water meters are used to $63.50 for 6-in. meters.

Charges for filtered water in Grand Rapids are 11c. per 100 cu.ft. for the first 1,100 cu.ft. used per quarter, 10½c. for the next 8,900 cu.ft., 10c. for the next 40,000 cu.ft., 9½c. for the next 50,000 cu.ft., 9c. for the next 100,000 cu.ft., and 8½c. for all over 200,000 cu.ft. used per quarter. In addition to the above commodity charge, the quarterly service charge ranges from $1.75 per quarter for ⅝- and ¾-in. meters to $11 for 6-in. meters. The minimum bill including service charges and water used is $3 per quarter.

It is intended to place again before the voters the matter of operating the sewer department as a utility in time to make the rates effective previous to the spring of 1930, when the sewage-works is completed. Of a $5,000,000 bond issue $3,500,000 has already been spent for reconstructing the sewer system and building new intercepters. The sewage-works, consisting of the activated-sludge process for treating presettled sewage with separate sludge digestion, has been designed and is now under construction. The plant, when completed, will have a capacity of 30 m.g.d.

Gerald J. Wagner is consulting electrical engineer for the city of Grand Rapids and has taken the leading part in conducting the campaign outlined in the foregoing paragraphs. Milton Adams is city sanitary engineer and Pearse, Greeley & Hansen, Chicago, are consulting engineers for the sewage-works.

Methods of Handling Quicksand in Sewer Construction

Quicksand Condition Defined—Methods of Handling Described and Appraised—Quicksand Clauses in Specifications Suggested

By A. P. Learned
Of Black & Veatch, Consulting Engineers, Kansas City, Mo.

THERE is much misunderstanding of what is meant by quicksand. The common conception is that it is a very fine sand full of water. In a paper read before the New England Water Works Association on Sept. 8, 1920, Charles R. Gow said: "Contrary to popular impression, quicksand, strictly speaking, is not a material but rather is a condition of a material. . . . Any material of a granular nature may become a quicksand if there is an upward movement of groundwater through it of sufficient velocity to lift and carry the individual particles. On the other hand, no such material will become quick in character unless there is such a flow of water."

There are a number of materials which when dry appear as shales or clays mixed with a very fine sand and which in the presence of water will often make a bad form of quicksand. The clay or shale seems to act as a lubricant for the sand grains and they flow even more readily than similar small-grained sand which is clean and free from clay. The same materials when dry or confined usually make a very substantial foundation.

Since quicksand is a condition rather than a material, the testing of underground conditions ahead of construction may not be indicative of conditions to be encountered during construction. In locations where the water table varies much, if the work is done when the water table is below the bottom of the excavation in material which in the presence of water would be quick, there will be no quicksand; but if the water table is above the bottom of the excavation at the time the work is done, there will be quicksand.

Quicksand Construction Conditions and Methods

The methods used in handling a quicksand situation will differ according to conditions. Some of the conditions that alter the methods of handling are: (1) Whether the excavation just penetrates the top of the quicksand, or whether it is quite deep into, or whether it is entirely through it; (2) whether the excavation is narrow so that shoring may be easily braced across the opening or whether it is a large excavation that will require sheeting stable in itself; (3) whether the adjacent area is built up so that no sliding or undermining can be permitted; (4) whether the excavated material is a clean sand, or whether it is full of a clay or shale matrix, and (5) whether the hydraulic head in the material in this condition is very high, or is practically in equilibrium at the top of the material in question.

Methods of Handling—Some of the methods used to handle a quicksand condition are: (1) Driving tight sheet piling, sometimes required for some distance below the bottom of the excavation to cut off the flowing in of material from the sides and ends of the excavation, thus cutting off the effective head on the material in the bottom of the excavation so that it is stable; (2) dewatering the stratum by means of well points or larger wells and sumps carried below the bottom of the excavation, thus keeping the water table below the excavation; (3) building mats of gravel, straw, cinders, boards or lean concrete in the bottom of the excavation; (4) building the structure on piles driven into the quicksand, the piles being driven until firm, and (5) using caisson and pneumatic processes in very deep and dangerous excavations. Very often a combination of some of these methods is used.

Appraisal of Methods—When the excavation just penetrates the quicksand and there is only a small head of water, a mat of cinders or gravel and, in wider excavation, a mat of lean concrete (1:4:8 mixture) can be used effectively.

When the excavation penetrates well into the quicksand, the tight-sheeting method with or without a mat, the dewatering process, the pneumatic process, piling, or combinations may be used.

When the excavation is through the quicksand, tight sheeting may be the best method. Often in very deep small sewer work it is cheaper to put down shafts 40 to 50 ft. apart, tight sheet these shafts through the quicksand and tunnel between the shafts in the more solid material.

The use of the well points for dewatering is limited somewhat by the material. A large number will be needed with a fine mesh inlet to let the water through where the sand is very fine, and if there is clay it may tend to mud up the points. In coarser, clean sand, however, and in very large excavations well points are very effective. Under some conditions larger single sumps are effective. Straw or hay may be placed outside the sheeting of the pump pit to let water through and hold the sand back.

There are difficulties in driving piling through quicksand. Supporting piles can best be jetted down. Tight-sheet piling is difficult to drive if not jetted and usually can only be driven by the use of a steam hammer with its rapid application of blows, too rapid for the material to bind between blows. The removal of steel sheet piling is practically as costly as is the original driving, for the material binds against the piling and flows into the interlocking sections.

Special Sewer Construction Methods—In sewer work great care is required to insure joints sufficiently tight to prevent the infiltration of sand or other material readily carried by water. Such infiltration through an imperfect joint not only tends to fill the sewer but also tends to cause a cave-in, a break in the sewer barrel or its settling out of line.

In small sewers in very adverse conditions pipe supports made of 2x8-in. timbers 4 to 6 ft. long have been used. One of these timbers is settled in place back of the bell of each joint of pipe to support the pipe joint. A V-notch is cut in the 2x8 to support the pipe and hold it in line. A band of sheet iron is brought up over the pipe and fastened to the pipe so that the pipe is held in position until properly backfilled. This method is costly and it is difficult to get satisfactory grade lines.

In several instances in which the quicksand effect has been cut off on the sides of the ditch by steel sheet piling it has been found necessary to keep the excavation open quite a distance ahead of the end of the sewer pipe to keep the pipe from being lifted by the head of water in the sand because this head had not been relieved by excavation far enough in advance.

The use of the concrete mat in connection with steel sheet piling has proved very satisfactory on several occasions on large sewers. Its value has been twofold.

It confined the quicksand and made a substantial floor for the workmen and it formed a cradle and broader bearing for the sewer barrel. In these cases the backfilling was done over the sewer to a point above the quicksand before the piling was withdrawn. It is well to place a piece of lumber on edge next to the piling to keep the concrete mat from contact with the piling.

Quicksand Specifications

The fact that quicksand is a condition rather than a material suggests that the specifications for excavation shall be drawn with clauses permitting an adjustment if the quicksand condition is encountered. The American Society for Municipal Improvements in a footnote to its published specifications on sewers suggests the following:

> In localities where quicksand is known to occur and can be defined, its inclusion as a definite item in the contract is recommended. Quicksand may be defined as a material the satisfactory excavation of which requires the use of close sheeting driven well below sewer grade, or the use of well points. In this instance, the price or bid for quicksand should be required to include the cost of sheeting, and of leaving it in place up to the upper limit of quicksand excavation and the furnishing and operation of well points if used.

The engineer should reflect in his specifications a method of compensation for a quicksand condition to protect the price of the remainder of the work by reducing the hazard in bidding, and at the same time protect the contractor if he should encounter quicksand.

Methods of Payment—The methods of paying for such a condition are to allow (1) the cost of the extra work done plus an agreed percentage of this cost or plus an agreed lump sum; (2) an agreed lump sum for the extra work to cover costs and profit; (3) an agreed lump sum per unit of length to cover possible conditions within certain limits or boundaries, and (4) unit prices as given in the original proposal to cover various types of construction.

The first method is, in the opinion of the writer, the fairest to all concerned, but is objected to by some because, they say, it creates a situation in which the contractor has no incentive to keep the cost down. Under such conditions the engineer should be in a position to direct or to check methods of doing the work and to decide whether the progress is commensurate with the conditions. This objection is a reflection on the contracting business which the writer thinks is generally undeserved. The percentage agreed on should be enough but not so large as to be unusually attractive.

In a contract in which there is allowed cost plus a percentage, the items which will constitute cost should be carefully outlined, and if the percentage added is for anything but profit it should likewise be clear as to what it will include. Very often the percentage is made a little larger than on the face would seem fair, but it is made to include all items of general overhead, such as general and field office expense, general wear and tear and depreciation of the large units of equipment and general insurance items.

The second method is one used often after the quicksand is encountered and to take care of political situations. The city wants to know the exact amount of the extra and there is an agreed extra lump sum for the entire job or at times an agreed extra price per foot of sewer. This, however, is likely to be unfair to either party, for the contractor may either overprotect or underprotect himself.

The agreed price per unit of length of certain types of construction will likely be quite fair if both parties are acquainted with conditions and with the methods applicable to the situation.

The inclusion of an item to cover quicksand in the original proposal will likely be unsatisfactory if none of the material was expected, and it did not enter into the original tabulation of bids for the work. The contractor might bid low, since he expected there would be no quicksand or, since it did not enter into the tabulation of bids, he might bid excessively high, and when the condition was encountered this high price would be the basis of settlement.

Suggested Specification—In conclusion, the following clauses are suggested as reasonable for inclusion in specifications, provided it is agreed to handle the work as extra work:

> Where quicksand conditions are encountered that require special methods and extra construction for the successful accomplishment of the work in hand, such work will be handled under the "extra-work" clause of this contract. The methods used and the rate of progress shall be subject to review and check by the engineer in charge of the work.

The extra-work clause would read as follows:

> The contractor shall do any other work not herein otherwise provided for and which may be found necessary in order to carry out and complete more fully the work herein agreed to be done and performed, when and as ordered in writing by the engineers or their authorized agents, with the approval of the owner; and the contractor hereby agrees to accept as full compensation for such extra work the actual cost of the work as determined by the engineers, plus 20 per cent of such cost. In computing such actual cost, no interest, rent, depreciation of plant, or general field superintendence and office expense shall be included. Actual cost shall include all direct labor, material incorporated in the extra work, direct superintendence, small tools actually worn out or lost on this extra work while engaged on the extra work, all liability insurance actually paid on labor and foremen engaged on said extra work, ordinary renewals and repairs made to large units of equipment and caused by the use on said extra work and occurring during the use on the extra work in the field. Timekeeper time will be prorated on the basis of men engaged on the various parts of the work.
>
> The contractor shall, on or before the 25th day of the month succeeding that in which any extra work shall have been performed, file with the engineers an account giving the itemized cost of such extra work, and shall give the engineers access to all accounts, bills and vouchers relating thereto. No extra work will be paid for unless specifically ordered as such in writing as aforesaid. No order for extra work, at any time or place, shall in any manner or to any extent relieve the contractor of any of his obligations under this contract.

First Monolith Laid in Great English Dock Scheme

An important stage in the great Southampton dock project, which will cost $65,000,000, was reached recently, when the first of the monolith blocks was placed in position. The ceremony marked the beginning of the dock wall, of which 1,000 ft. will be available for the accommodation of the world's largest liners in two years' time. Seventy-eight of these concrete monoliths, each weighing 7,875 tons, will have to be sunk into the riverbed. The contract is being carried out by Sir Robert McAlpine & Sons.

The line of monoliths forming the quay will be covered with a concrete deck, which, with filling above, will constitute the finished quay on which provision will be made for the necessary lines to carry the quay cranes and railroad tracks. Among the materials to be used in the work will be 675,000 tons of gravel for concrete, 101,250 tons of portland cement, 2,925 tons of steel in monolith shoes and 2,825 tons of steel in reinforcing bars. Following as closely behind the construction of the quay as possible, cargo and passenger sheds, railways and electric light and water services will be installed.

Study of Mixing Action in Large Concrete Mixers

Concrete Quality and Mixer Efficiency as Influenced by Method of Charging, Size of Batch, Speed of Rotation, Richness of Mix, Water Content, Time and Place of Applying the Water, the Form of Chute and Other Variables

THE FOLLOWING is a much condensed abstract of a report to the Koehring Company of Milwaukee, Wis., by Prof. A. N. Talbot, University of Illinois. The tests were planned in collaboration with R. W. Crum, director, Highway Research Bureau, Washington, D. C., and R. L. Brown, associate in the Engineering Experiment Station, University of Illinois.—EDITOR.

THE tests were undertaken to determine the mixing characteristics of concrete mixers. Primarily there were studied (1) the batch capacity; (2) the volume, shape and size of drum to handle a given size of batch advantageously; (3) the mixing action produced by blades and buckets of given design; (4) the effect of changes in the interior design of the drum; (5) the kind of mixing action required to produce high-grade concrete; (6) the means of providing adequate transverse movement of the batch; (7) the effect of the method and place of applying the mixing water on (*a*) the quality of the concrete and (*b*) the accumulation of deposits and clogging; (8) the properties of the mixer which affect rapidity and uniformity of discharge; and (9) the effect of speed on the mixing action and on the time and quality of discharge.

Test Constants and Variables—Quality and grading of materials, methods of proportioning, etc., were kept constant and within commercial practicability. The variables were (1) size of batch, (2) speed of rotation, (3) richness of mix, (4) water constant, (5) time and place of applying water and (6) form of chute (swing or withdrawing).

Sampling and Testing—The mixer was stopped at intervals and in many of the tests samples were taken from different parts of the drum. Samples were taken one after another throughout the discharge from the drum and their uniformity or lack of uniformity determined. Samples were screened to find the proportion of fine and coarse material, weight per cubic foot was obtained, flow tests and slump tests and test cylinders were made. All sampling and testing methods conformed to standard and approved practices. Information on the nature of the mixing action and of conditions in the mixer was obtained by visual inspection.

Indications of Studies

The tests give pertinent and useful information on mixing characteristics, on variations in mixing action and on the sources of variation. They also throw light on some of the requirements for the proper mixing of concrete.

Charging the Mixer—The form of charging skip is best that gives a marked and effective mixing of the dry materials. Thus upon entering the drum a very large part, perhaps 75 per cent, of the shrinkage in volume from the sum of the volumes of the separate materials is accomplished.

There are advantages in having the time in charging longer than a possible minimum. For the first part of a revolution of the drum the intermingling of materials may be small. Later, with materials flowing down the swing chute as the remainder of the batch is being added, the intermingling is facilitated; a somewhat longer time of charging may therefore be expected to give quick intermingling in a very effective way. It would appear that the time of charging (inflow of material) should be at least two revolutions of the drum. That is to say, eight seconds of time for the materials to enter the drum may well be the minimum, and a somewhat longer time up to four revolutions of the drum would be advantageous provided the application of mixing water is properly distributed with respect to this time.

Mixing Action—Two forms of mixing action are needed: (1) intermingling the ingredients and (2) rubbing or scrubbing action among the particles themselves.

Effective intermingling requires movement of the particles relatively to one another both circumferentially and longitudinally of the drum. Mere movement of the batch is insufficient. There must be movement of particles relatively. Especially in relatively dry concrete is it both important and difficult to provide sufficient and varied transverse movement. Rubbing of the particles is obtained principally through the flow of the particles past one another (flowover) as they spill over the mixer blade edges. A stream of materials all moving together (stream flow) is devoid of rubbing action; showering action is also ineffective except for small rubbing when the materials alight at the bottom of the fall.

Even slight adhesions on the mixing surfaces injure the mixing action (1) by increasing the stream flow and decreasing the flowover movement and (2) by decreasing the transverse action of the mixing blades. Even an unused clean drum works better after a scouring by the mixing of a few batches. The slower speeds of rotation give a better mixing action; dry and medium mixes need a slower speed than do wet ones. A fine sand mixture requires more vigorous action than one of coarse sand. A rich mix has less scouring action than one with more aggregates and needs a well-designed mixer to obtain good results. But while a greater proportion of aggregates tends to more vigorous mixing, the opportunities for segregation are greater with improper speed and poor inside drum design. Broken stone, especially in large sizes, gives active movement in the drum with fewer adhesions and deposits.

In conclusion, the tests show variation in the nature and quality of the mixing action according to smoothness of inside drum surfaces, speed of rotation, wetness of mix, richness of mix and nature and amount of the fine and coarse aggregates.

Application of Mixing Water—Trial was made of five methods as to time, place, etc., of applying the mixing water. The tests led to the following conclusions:

1. A single point of application may be sufficient provided the discharge is at a place where the water will both lubricate the drum and be taken up by the material. The proper place is at the right of the charging opening a foot or so back of the face of the drum. The direction of discharge should be downward so that the water will strike the shell at a place free from materials and

then spread laterally and downward over this part of the shell before rotation carries it to the materials.

2. The water discharge should be a forcible stream and not be sprinkled on the materials of the batch.

3. The water should appear in the drum ahead of the other materials by two to three seconds or, better, five seconds.

4. To insure wetting all the batch, the water should continue to discharge for four to five seconds after the skip has emptied.

5. To obtain optimum conditions of mixing, by far the larger part of the total mixing water, preferably 75 per cent or more, should be applied in the drum. If half or more is contained in the aggregates as they enter the drum, conditions may and probably will develop conducing to slow mixing and discharging and to the formation of adhesions and deposits. The amount of water that may be charged with the aggregates without causing troublesome conditions will vary with the nature of the aggregates, the richness and wetness of the mix and the proportions of the ingredients. There may be conditions of materials and mix that will permit the use of a small volume of applied water without introducing unfavorable mixing operations, but such conditions are not common.

In connection with the last conclusion it may be well to note that in the inundation method a considerable part of the mixing water is used in saturating the sand as it fills the measuring receptacle. Additional water is then supplied to the drum to make up the required volume. This addition is generally a small part of the total; in mixes having a large proportion of sand or a small amount of cement or for dry mixes it is very little, and in some mixes it may be nothing. It follows that there is little or no water for cleansing and lubricating the drum. It not infrequently happens in operating a mixing plant that in order to apply more water in the drum than the surplus beyond inundation, the inundation water is decreased and the sand is not fully inundated. Then the sand does not flow freely and trouble is found both in the charging and in the mixing. Less than full inundation gives conditions unfavorable to mixer operation and fails in accurate measurement of materials. It may be added that if more than half the mixing water enters the drum in the sand the operation of mixing the batch may be seriously affected.

Discharging the Mixer—Consideration was had only of chute discharge; both quality and time of discharge were studied. Quality involves uniformity of concrete, lack of segregation and regularity and quick ending (lack of dribbling) of discharge.

An increase in speed may not result in decreased time of discharge, because the buckets are not as well filled at higher rotational speeds. Roughness or deposits on the blades increase the time of discharge; the effects are greater with drier and richer mixes. A blade angle of 60 deg. gives a faster discharge and a quicker ending than does one of 45 deg. Under normal conditions of regular field operation the time of discharging the full batch can hardly be less than 2 or 2½ revolutions (say eight to ten seconds). The time also will depend upon the mix and the nature of the aggregates. Drum length and interior design being the same, an increase in diameter decreases the time; similarly for the same volume of drum the shorter it is the shorter is the discharge time.

Segregation during discharge and dribbling discharge may both be obviated by adopting a proper angle and number and shape of blades and by controlling the design of buckets and chute and the speed of rotation.

Value of Swing Chute—Tests were made with both swing chute and withdrawing chute. They show that the swing chute is an important factor in securing satisfactory mixing action, proper distribution of water, uniformity throughout the batch, quicker intermingling action and maximum batch capacity.

Batch Capacity—The relation between the volume of the batch that can be handled satisfactorily and the volume of the drum itself can be determined only by experiment or trial. It depends upon the proportions of the drum and its internal design and upon the characteristics of the concrete to be mixed.

In general, a dry mix requires a somewhat larger size of drum—that is, the batch capacity for a given size of drum will be smaller. More space circumferentially between buckets is also required and also between one blade and another, especially in the zone common to buckets and blades. More time is required for the flow into bucket spaces and blade spaces, and hence a lower speed of rotation is needed. The dry mix spills out at a higher angle of the rotation, which also permits and requires a lower speed for effective action. A greater dip or angle of slope in the blade is needed to give effective transverse action, and a greater blade angle to produce sliding of the material along the blade.

Dimensional Proportions of Drum—It is apparent that the relation between the length of the drum and its diameter has a bearing upon the mixing qualities of a mixer and in even larger measure upon the discharging properties of the mixer. It is apparent that too long a drum will be defective in transverse movement of the batch during mixing operation, rendering it difficult to distribute the water and cement quickly throughout the batch. The longer blade space just referred to has a still greater effect on the discharging operation, taking more time for the discharge and giving opportunities for more segregation.

Speed of Rotation—It is evident that for proper mixing action the speed of rotation should be such that the materials in the blade spaces and bucket spaces will be carried to a height and sufficient time be given to enable them to roll or flow down the slope and not be carried as a stream or catapulted into the interior and fall in a shower. The speed for any drum is a function not only of the size of the drum but of the design of blade and bucket.

Study of Design of Blades

Tests were conducted on both a 27E paver and a 21S mixer. The general conclusions were:

1. The combined effect of increasing the blade angle to 60 deg. and decreasing the number of buckets is to give a more rapid and positive transfer of the materials longitudinally of the drum during the discharging operation and to fill the bucket spaces quickly and fully, and thus to place the batch on the discharge chute rapidly and effectively. The result is a marked shortening in the time of discharge, a quick ending of the discharge and very little dribbling at the end. There is also freedom from segregation of the materials, the batch as discharged being in the same condition of uniformity as that found in the drum at the end of the mixing operation.

2. Although little difference was observable in the mixing action, it is believed that the effect of the greater blade angle is to give better opportunities for the remixing action carried on through the instrumentality of the mixing chute to promote transverse movement of the

materials during the mixing operation. The smaller number of buckets results in less obstruction to transverse movement of materials. Likewise the changes are helpful for the charging operation.

3. It should be an accepted principle of design that the position of the blades and buckets and the shape of the buckets should be such as to facilitate the transverse movement of the materials during mixing and discharging and to allow comparatively free fall into the bucket spaces during the discharging operation.

The Chicago Sanitary District Situation

Politics and Shortage of Funds Combined With Court Prohibition of Lake Diversion Creates Desperate Plight

LACK of funds, mismanagement and the recent Supreme Court decision necessitating a large and immediate construction program for sewage treatment works has brought the Sanitary District of Chicago to a very serious situation. New construction will probably include provision of a higher degree of treatment for some if not all the plants already completed or under way, and both hastening the works now in the preliminary design stage and intensifying the treatment. Present shortage of money has led to only partial operation of some of the completed plants and to temporary stoppage of construction. Of the three larger works, the North Side plant is completed but is operated with only 25 per cent of the designed flow; the first battery of the West Side plant is practically completed, but progress is now delayed for lack of funds; the Southwest Side plant is still in the preliminary stages of investigation. Of the medium-sized plants, the Des Plaines and Calumet are in operation, but the latter has to be enlarged. Of the smaller plants, those serving Morton Grove, Glenview and Northbrook are in operation, but together they serve only a few thousand people.

Attempts to sell a bond issue for $27,000,000 for the district's construction program failed last fall because of legal proceedings brought by a taxpayer, and this failure was the cause of the present financial crisis. A law which went into effect on Jan. 1 requires such bond issues to be submitted to a referendum vote. To avoid the delay and expense involved in this procedure, the district has applied to the state legislature for authority to issue the bonds without a referendum, in order to provide for carrying on work required under the present permit of the Secretary of War or by reason of the decree of the Supreme Court.

By the Supreme Court decision diversion of water from Lake Michigan will ultimately be prohibited except so far as water is required for navigation in the Chicago River, and the amount for this purpose is characterized as negligible. (See *Engineering News-Record*, Jan. 24, 1929, p. 146.) Under these circumstances it will have to provide treatment for the entire sewage flow within the district, or for an estimated population of 3,710,000 in 1930, for a considerable portion of which works of varying degrees of efficiency have been constructed or are now being built. The permissible diversion from Lake Michigan, ultimately and during a probation period, as well as the length of that period, is to be determined by Charles E. Hughes, as special master for the Supreme Court. The hearing in this case has been set for March 25, in Chicago.

The engineering department is working on a program and plans for works that will meet the conditions imposed. The district has also appointed a board of engineers to advise upon the technical aspects of the situation. But the court decision emphasizes the need of extensive works and rapid construction. Hence the pressing problem is that of providing funds for this very important work and also insuring proper use of the money.

Gross mismanagement in the affairs of the Sanitary District is shown by the recent report of a grand jury investigation. The district has long been recognized as a political machine, and its political activities reached a climax just before the elections of last November, when its payrolls were padded with local politicians and city and state legislators. Since then there has been a radical reduction in the number of employees, but nevertheless the funds have been insufficient to meet even the payroll for about 1,200 employees, as against 4,780 in November. Further investigation of the affairs is being carried on by the state's attorney.

Numerous important public works have been designed and carried out successfully by the engineering department, but this department has no protection in the shape of civil service. It may be recalled that some years ago the trustees made almost a complete sweep of the engineers and put a young and inexperienced man as chief engineer over the few remaining men. There has been no recent complaint as to the efficiency of the engineering department, although all departments have been overloaded with employees.

The board of trustees which administers the affairs of the district has been shown to be run on the spoils system and on the basis of political and personal benefit, utilizing for these purposes the vast sums of money which it has had at its disposal for expenditure on public works and in the public interest. Its operations have reflected a general lowering of the morale of officials intrusted with the conduct of public business. From the lengthy and scathing report of the grand jury the following points are taken as to political control and general mismanagement.

1. The trustees were "apparently appallingly ignorant of any of the affairs of the district except patronage."

2. "There now is apparently a deficit of $9,602,355 in the bond fund—that is to say, there has been a diversion of bond revenue to meet operation and maintenance cost and like obligations." This deficit is "one of the lesser evidences of gross mismanagement that directly may be attributed to a startling disregard of their duties as trustees and inconceivable carelessness."

3. In the evidence as to padded payrolls, it was shown that many members of the state legislature "did nothing whatever for the very substantial pay they received from the district in 1927-28," and "all of these men were professional politicians of a low order." Other members stated they had received no money from the district, although their names appeared upon the payroll.

4. That the district was organized upon a bipartisan agreement was frankly admitted by the trustees. "The consideration in each instance was patronage. . . . This arrangement is definitely reprehensible. . . . Its payrolls have been used to perpetuate bipartisan political machines. The practice is viciously ridiculous and receives the certain condemnation of this grand jury."

5. The capital investment of the district is $155,221,500. "That vast sum is now under the care and management of the professional politician."

6. In view of the number of concerns in every business, the report says it is strange that "contracts should repeatedly be let to the same contractors, particularly when certain of these same contractors long have been active in local politics." Further, since 1926 the practice of attaching plans and specifications to the proposals was discontinued, so that an intending bidder would have to hunt for the information. "It is obvious that those sought to be favored would not be confronted with that difficulty."

The drastic cut in the payroll of the Sanitary District, though made under pressure, is considered to indicate an intent on the part of those now in control to conduct its affairs on a business basis. It is understood that an efficiency survey of the organization is being made and there is some reason for hope that in the future its affairs will be administered in an honest and competent manner.

Letters to the Editor

Wrestling With Traffic

Sir—Your editorial in the Jan. 31 issue of *Engineering News-Record*, "Wrestling With Traffic," has a wide application. The problem is general and most of the proposed remedies are mere palliatives and not solutions. Every city is an individual case. I have presented in the following letter what appears to be an original answer for Kansas City's difficulty. More or less modified, this principle might be helpfully considered by other cities similarly situated. Some extracts from the letter are as follows:

Removal of parked cars from the streets of the business district will increase the roadway capacity for moving traffic 100 per cent. The effect of this, together with proper regulation of traffic, would be the remaking of the central business area. But how?

We do not want more government in business, least of all more city government. Yet it is admittedly a proper function of government to provide highways and stopping places for vehicular traffic. But at present we are not doing this either effectively or economically. Street space in front of large buildings on land that is worth fabulous sums is used to accommodate a transient "Tin Lizzie."

If the city were forced to make a direct charge, based upon this capital value of its street space used for parking, the community would have an awakening. No city can afford such an expensive burden.

But the indirect cost of this parking practice on public streets is incalculably greater. It has driven business from the convenient downtown district. It has destroyed millions in actual property values and untold sums in potential values.

If it has always been proper for government to furnish highways and stopping places for its citizens, then a new era in transportation now makes it obligatory upon our city to furnish freedom of movement on our streets and proper parking space for its vehicles.

This cannot be done, either actually or practically, by widening the streets; neither should this public function be left to private initiative.

Convenient free public garages are the only solution of this vital problem for Kansas City. It is the duty of our city to provide these for the convenience and profit of all its citizens. All the private garages now here are needed. They should be taken over by the city for free parking. Others should be built as needed. This can properly be done only after a thorough economic survey has been made by a disinterested expert. This, by the way, would certainly show that no subterranean parking station under the city would be economically possible.

Perhaps the size and universal importance to Kansas City of this program would indicate a bond issue as the best way to finance it. But if the merchants and property owners of the downtown district are awake, they will accept a downtown benefit district rather than let such a vital matter drag.

A few figures will give this principle concrete finality. There are properties in our downtown area worth $5,000, $10,000 or even $20,000 per front foot, or on the basis of 100-ft. depth, respectively $50, $100 and $200 per square foot. The street space in front of these properties is certainly worth twice as much per square foot. On this basis, street space in front of property worth $10,000 per front foot is worth $200 per square foot.

Within a suitable and convenient distance of every piece of such valuable property is land worth $500 to $1,000 per front foot. A five-story garage on $1,000 a front foot land would have a land cost of only $2 per square foot. Such a garage could be erected for $4 per square foot, a total capital outlay of but $6 per square foot for efficient parking. This compares with the present capital outlay for street parking of $200 per square foot, thus giving the startling ratio of 33 to 1 in favor of housing cars in a garage.

Every property owner having such interests could donate such garage space and for every foot so pledged reap a 16 to 1 reward.

Kansas City, Mo., Feb. 11, 1929. C. W. REDPATH.

Pavement Use and Width

Sir—The editorial in the issue of Feb. 28, under the caption "Pavement Use and Width," recalls to me an additional reason for increasing the present practice in connection with the widths of roads to be constructed.

While the primary purpose of a road is to carry the traffic of peace times, it should not be considerd that this will be its only use. Those familiar with the conditions in France attending the movement of both men and materials during the last war are, I think, practically unanimous in the opinion that road conditions bear a very important relation to both strategy and tactics of an army, whether on the defensive or offensive, and I think that most of these same men will agree that for military purposes at least a road should be so constructed that it will comfortably carry not less than three lines of traffic, taking into consideration the fact that practically all movement in what is termed the zone of the advance takes place at night and without any lights whatsoever.

I feel that in building roads in this country, particularly those within a hundred miles of the coast or frontiers, the minimum width of any road should be that suggested above, as the day may come when, regardless of the demands of peace-time traffic, the investment may pay handsome dividends in assisting our armed forces in the defense of the country.

New York City, March 2, 1929. R. S. TILDEN.

Continuous Girder Bridges

Sir—Your editorial article on continuous girder bridges in your issue of Jan. 17 is incomplete in its historical references by failing to give credit to C. Shaler Smith, who was the first engineer to use this system. He applied it in his single-track railroad bridge over the Lachine Falls in the 80's, a bridge which twenty years later was replaced by a stronger double-track bridge having simple trusses.

Even before this I had been an advocate of the continuous girder type of construction. I believe also that I was the first engineer in this country to use continuous girders on a large scale, in the Sciotoville bridge. Since then the Steubenville bridge over the Ohio River, with three spans, was built for the Pennsylvania Railroad; I suggested the continuous system for this bridge and made the check calculations. Only recently I completed two city bridges of the continuous girder type over the Willamette River in Portland, Ore., one of three spans, another of four spans.

New York City, Feb. 13, 1929. G. LINDENTHAL, Consulting Engineer.

News of the Week

Herman Smith Appointed Head of New York City Engineering

Herman H. Smith, formerly deputy chief engineer of the Board of Estimate and Apportionment, New York City, has been appointed chief engineer of the board to succeed Arthur Tuttle, appointed consulting engineer to the board on Nov. 1, 1928. Mr. Smith has been acting as chief engineer since Nov. 1. He is a graduate of the Massachusetts Institute of Technology and began his practice of engineering with the Long Island Railroad in 1898, remaining with that company until 1903, when he took an engineering position in the Brooklyn Bureau of Highways. In 1906 he was placed in charge of the construction division of that bureau and in 1907 was made engineer in charge of maintenance of the same bureau. Three years later he became acting chief engineer and subsequently chief engineer of the bureau, which position he held until, in 1921, he was transferred to the Board of Estimate and Apportionment to become deputy chief engineer under Mr. Tuttle, who had just been made chief engineer.

For a number of years Mr. Smith served as chairman of the various standard paving specification committees of the American Society of Municipal Improvements.

Aswan Dam to Be Raised

The Egyptian government has officially ordered the construction of the addition to the Aswan dam on the Nile River as proposed in the report of a board of three engineers, of which Hugh L. Cooper, of New York, was a member. The report of this board was abstracted in *Engineering News-Record*, Feb. 14, 1929, p. 278.

Responsibility for carrying out the work has been placed in the hands of Sir Murdoch Macdonald & Partners, of London, England, as recommended by the commission.

A Nebraska-South Dakota Railroad

Construction work is in progress on the 66-mile line of the Yankton, Norfolk & Southern Railway, extending south from Yankton, S. D., on the Great Northern Railway and the Chicago, Milwaukee, St. Paul & Pacific Railway, to Norfolk, Neb., where it will connect with the Chicago & Northwestern Railway and the Union Pacific Railway. It will also cross the Chicago, Burlington & Quincy Railroad. It is expected to have the road completed to a connection with the Chicago & Northwestern Railway at Pierce, Neb., about 50 miles, before October, 1929.

Bids Opened for Approaches of Kill van Kull Bridge at New York

Bids for the construction of 37 piers for the approaches of the 1,675-ft. steel arch bridge over Kill van Kull between Bayonne, N. J., and Port Richmond, Staten Island, were opened by the Port of New York Authority on March 4. Thirteen bids for the eighteen piers on the New Jersey side ranged from $387,930 by the P. T. Cox Contracting Company, Inc., New York, to $571,500 bid by Louis Di Menna, and nineteen bids on the nineteen piers on the Staten Island side, ranging from $314,780 by the Arthur McMullen Company to $555,415 by the Tilt-Hargan Company, all of New York. The bids are said to compare satisfactorily with the engineers' estimates.

The approach piers will be of reinforced concrete with heights ranging from 20 to 110 ft.

Canada to Hold Conference on St. Lawrence Waterway Project

Premier MacKenzie King of Canada has announced that in order to enable the resumption of negotiations with the United States in regard to the St. Lawrence waterway project a conference will be called, at the close of the session of Parliament, between representatives of the dominion and the provinces of Ontario and Quebec. The dispute which arose as to the ownership of the water powers to be created by the project halted the negotiations for the time being, and an appeal to the Supreme Court left the question still unsettled. If a satisfactory arrangement of the dispute can be effected by an agreement between the dominion and the provinces, the way will be cleared for the reopening of the negotiations. The Premier stated that no treaty would be finally negotiated with the United States until Parliament has ratified every clause.

F. C. Austin Establishes Fund to Train Students as Executives

Northwestern University, Evanston, Ill., has received an endowment estimated worth $200,000 annually from Frederick C. Austin, Chicago, manufacturer of highway and construction equipment, to be used for the training of selected students as business executives. The building at 111 West Jackson Blvd. in Chicago, valued at more than $3,000,000, has been given by Mr. Austin to provide a source of income for the endowment. The fund will be expended on the training of students who appear to have the qualifications necessary to fit them as leaders.

Decision Reached in Syracuse Grade Separation Project

A decision as to how the tracks of the New York Central Railroad are to be taken off the streets of Syracuse, N. Y., was reached by the Syracuse Grade Crossing Commission on Feb. 25. Since the early days of railroad construction the trains of the New York Central have operated along one of the principal streets of the city and in recent years conditions became so acute that a state commission was appointed to handle the matter. More recently F. H. Fay, of Fay, Spofford & Thorndike, Boston, reported upon a number of possible ways of removing the tracks from the city streets. The plan approved by the commission is reported to be a modification of one of Mr. Fay's proposals. It calls for a four-track elevated structure along the line of the present two tracks of the West Shore Railroad and the construction of a new station at Howard St.

There is strong opposition to this location and a move is on foot to have the commission's action nullified or set aside by court proceedings.

Improvements by C. & O. Railway

Improvements, extensions and betterments, at an approximate expenditure of $18,403,000, will be made by the Chesapeake & Ohio Railway at various points on its system, according to W. J. Harahan, president. These improvements include additional shop facilities, trackage, engine terminal facilities, freight and passenger depots, and grade-crossing separations. Practically every part of the system will be benefited. Preliminary plans for the work have been completed, and actual construction will be started without delay.

New Orleans Engineer to Build Railway in China

Arthur M. Shaw, of New Orleans, sailed from San Francisco on March 1 for China to begin work on a railway that will connect north and south China, in accordance with a two-year renewable contract with the Chinese National Construction Commission. Mr. Shaw, for 37 years an engineer, has many notable achievements to his credit, including large irrigation and drainage projects and development of engineering devices and methods. He was connected for eighteen years with the Illinois Central Railway and has acted for the U. S. Department of Agriculture as a drainage expert. From 1923 to 1925 he supervised plantation work in Honduras for the Cuyamel Fruit Company, of New Orleans.

Oldest Aviation Magazine Joins McGraw-Hill Group

Aviation, the oldest aeronautical magazine in the United States, announces in its current issue (March 2) that it has joined the group of technical and business papers of the McGraw-Hill Publishing Company, Inc., the latter having purchased the capital stock of the Aviation Publishing Company of New York City. Earl D. Osborn, publisher of *Aviation*, will join the McGraw-Hill organization and continue his editorial activities in the aeronautical field. The magazine is a weekly and was established twelve years ago by Lester D. Gardner, until recently president of the Aeronautical Chamber of Commerce and now president of Aeronautical Industries, Inc.

Mr. Osborn, in announcing the merger to the readers of *Aviation*, calls attention to the manner in which the journal has served the aeronautical industry. Through association with the McGraw-Hill company, he states, it will have the advantage of greater resources and publishing facilities as well as close contact with other technical fields that are becoming more and more closely allied with aeronautics.

In commenting on the merger, James H. McGraw, chairman of the board of the McGraw-Hill Publishing Company, makes the following statement: "The rapid evolution and progress of aviation as an art and as an industry demand a high order of journalism to keep pace with advancing thought and with the flow of news. Also, while it stands out as a new industry, aviation has within itself many problems which parallel those in older industries. These problems embrace the broad sweep of manufacture and distribution; of civil engineering, as in the proper construction of airports; of electrical engineering, as in adequate lighting of airways. Chemical engineering is involved in paint problems, in lubrication and in the surfacing of wings. All of these problems, hardly visualized by the aviation enthusiast, are day-by-day companions of the men who are developing this new industry. As we see it, our publishing opportunity lies in helping them in this work through the pioneer paper in their field."

Improvements Projected at Duluth-Superior Harbor

Projected improvements at the Duluth-Superior harbor, revised for 1929 by the U. S. Harbor Engineers department at Washington, will involve an expenditure of $5,290,000, exclusive of amounts expended under previous projects.

The plans include the rebuilding of the canal piers at the Duluth harbor entry with stone-filled timber crib substructures and concrete superstructures; the replacing of the north and south piers at the Superior entry with concrete piers; constructing 4,205 ft. of rubble stone mound breakwaters, 900 ft. of concrete pierheads on stone-filled cribs and 896 ft. of concrete shore revetments at the Superior entry.

Other projects to be undertaken will include the dredging of a lake approach to the Duluth entry; dredging between piers at the Superior entry; dredging a central channel 600 ft. wide between the breakwaters and pierheads; dredging a harbor basin of 380 acres, and dredging channels varying from 100 to 600 ft. in width throughout the harbor and aggregating 17 miles in length to a depth of 20 ft.

Tube to Relieve Baltimore Traffic

Recommendation that a tube be constructed under Franklin St. from Howard to Calvert St., Baltimore, is made in a report to Mayor William F. Broening by the Baltimore traffic committee. This recommendation is made to follow adoption of numerous other traffic relief plans suggested by the committee.

Charles F. Goob, chief engineer of Baltimore, is chairman of the committee. Other members are Nathan L. Smith, engineer at the head of the municipal bureau of highways; Dean J. Locke, of the engineering department of the United Railways & Electric Company; Police Inspector George E. Lurz, Charles A. Jording, president of the board of fire commissioners; Warner T. McGuinn, chairman of the city council committee on highways, traffic and bridges, and P. B. Stearns, of Stewart & Company.

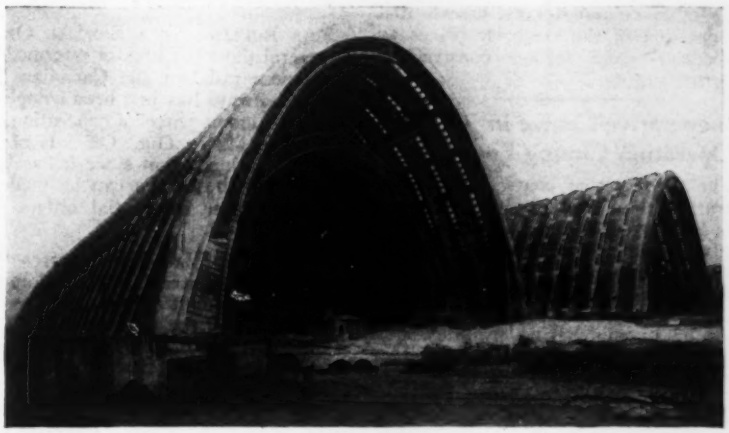
California Company to Build 300,000-Hp. Steam Plant

Erection of a 300,000-hp. steam-electric generating plant in San Francisco by the Pacific Gas & Electric Company will be started soon. The new plant when completed will be almost three times the size of Pit No. 3 hydro-electric plant, which is the largest power plant on the company's present system. Two 70,000-hp. units will be started at once and it is planned to put them in operation during 1930. The complete plans call for a five-year construction period with a total expenditure of over $11,000,000.

Large Paper Mill Under Way in Quebec

Construction work on a 250-ton paper mill and a 75-ton sulphite pulp mill to be erected by the James Maclaren Company, Ltd., at Buckingham, Que., about 16 miles east of Ottawa, has been started by the Foundation Company of Montreal, which has the contract. The job will cost about $6,000,000. Construction of the hydro-electric power development at High Falls, a part of the project already under way, will account for a further expenditure of $5,000,000, and the Cedar Rapids storage dam $1,500,000, making a total of $12,500,000. The installation of hydro-electric power at High Falls, 23 miles north of Buckingham on the Lievre River, will be 90,000 hp. initially in three units, with provision for a fourth unit of 30,000 hp.

REINFORCED-CONCRETE AIRSHIP HANGARS AT ORLY, FRANCE



These unusual structures are in use at the Orly airport, about 10 miles south of Paris. The monolithic pointed arch vault design was evolved by Limousin & Company after experience with circular vaulted hangars, about 50 of which were built from 1916 to 1920. Similar French hangars were described in *Engineering News-Record*, Oct. 9, 1919, p. 702. The hangars pictured above are approximately 984 ft. long, and the arched cross-section is about 300 ft. wide by 195 ft. high. As may be seen on the far hangar, there is a regular corrugation of the surface, each corrugation in section resembling zee-bars or trough-plates. Beams tie these trough-plate elements together, and between the beams are windows fitted with yellow glass to protect the airship fabric from harmful sun rays. There are no girders or projecting ribs either inside or outside of the hangar surface. The neutral axis of each of the elements is in the form of a catenary corresponding to its weight. Large doors of structural steel are used in both ends of the hangars and provide an opening of about 250x175 ft.

Indiana Section of A.W.W.A. Meets at Indianapolis

Attendance at the annual meeting of the Indiana Section, American Water Works Association, Feb. 27-28, totaled 170. The following officers were elected: President, I. L. Miller; vice-president, W. C. Ridgeway; secretary-treasurer, C. K. Calvert, 1902 North New Jersey St., Indianapolis (re-elected).

On the second afternoon, two sessions were held, one for plant operators and one on fire prevention. At the latter, Frank C. Jordan, Indianapolis, presided and papers by Clarence Goldsmith, New York City, and Percy Bugbee were read and discussed. The presiding officer at the other session was L. S. Finch, Indiana State Board of Health. Three papers on chlorination, one on coagulant dosage and on filter operation were read. Among papers at the general session were one on Tastes and Odors, by Charles E. Trowbridge, American Water Works and Electrical Company, and one on Increasing Sales of Water Service, by W. H. Durbin, Terre Haute, Ind.

I. C. C. Establishes Freight Rates on Lumber

The Interstate Commerce Commission, in a decision made public on Feb. 26, authorized transcontinental railroads and their connecting lines to establish or continue freight rates on lumber and other forest products, subject to certain limitations, over indirect or circuitous routes from south Pacific coast territory to points in central territory lower than the rates for intermediate points.

A dissenting opinion, written by Commissioner Eastman and concurred in by three other commissioners, asserts that the decision of the majority places an unnecessary and wrong construction upon the statute.

Co-operative Course in Railroad Operation Closing First Year

The co-operative course in railroad operation conducted at the Massachusetts Institute of Technology in conjunction with the Boston & Maine Railroad is now completing the first year of its operation. This course was established in recognition of the increasing importance of an engineering training as a background for those who are to enter the field of railroad transportation. Its object is to provide fundamental training in the principles of modern science and practical experience in the operating department of a progressive railroad.

At the present time students are registered in the first three years of this course, which was established in February, 1928. The students in Group A, third year, are now with the mechanical department of the railroad, completing an eighteen-week period in all the important departments of the railroad.

The course in railroad operation is administered through the civil engineering department of the Institute.

Brief News

WORK WAS COMMENCED on the construction of the 5,000,000-bu. terminal grain elevator at Prescott, Ont., on Feb. 20. This is part of the scheme to develop a lake port for deep-draft vessels on the St. Lawrence at Prescott.

THE KENTUCKY UTILITIES COMPANY is making a park at the Dix River hydro-electric development in Kentucky. More than $60,000 will be spent in building a tourist camp and developing roads at the site of the Dix River dam, a rockfill 275 ft. high.

CONSTRUCTION WILL COMMENCE shortly on the Abitibi Southern Railway, which will connect Amos, in the mining area of northwestern Quebec, with Maniwaki and Mont Laurier and thus provide through transportation over existing Canadian Pacific lines to Ottawa and Montreal.

WORK HAS BEEN STARTED on a $750,000 addition to the Sears-Roebuck plant in Atlanta, Ga., to be completed the first of September. The new addition will have a frontage of 120 ft. and a depth of 140 ft. and will be nine stories in height. It will add about 150,000 sq.ft. of floor space to the present unit, completed in 1926.

THE WYOMING SENATE killed the measure which sought to create a department of engineering research at the University of Wyoming for which an appropriation of $20,000 had been provided in the general appropriation measure. It also killed the Governor's measure which provided for the construction of 1,000 miles of highway at a cost of $7,500,000.

THE ROLLING OF A SPECIAL ORDER of several thousand tons of intermediate manganese rails for the Canadian National Railways has just been completed by the Algoma Steel Corporation, of Sault Ste. Marie, Ont. Officials of the company intimate that since it has been shown that these rails can be made in Canada further substantial orders will follow.

A RECORD WAS ESTABLISHED last year by the Montreal Harbor Commission in the amount of new work undertaken. During the year about 2,250 ft. of new wharf was laid down, the greatest amount of this class of work ever accomplished in any one season in the history of the port. For this twenty cribs were sunk in the harbor by contractors under the supervision of the harbor engineering staff.

MORE THAN 576 MILES of right-of-way on roads that come within the master plan of superhighway classification have been acquired by the road commissions of Wayne, Oakland and Macomb counties, Michigan, since the master plan was adopted three years ago.

THE CANADIAN HOUSE OF COMMONS recently approved a resolution calling for an immediate investigation of the project to build a canal across the isthmus of Chignecto, which connects the provinces of New Brunswick and Nova Scotia. The investigation is to go into questions of feasibility, cost of construction and economic and national advantage to be gained from the construction of such a waterway.

THE FIRST AIRPORT CONVENTION ever held will be staged in Cleveland, May 16-18, sponsored by the airport section of the Aeronautical Chamber of Commerce. A tentative program includes discussions and addresses on various phases of airport lighting, landing field construction and care, interfield communication and meteorology, design and architecture, safety control, maintenance and administration, and standards of practice.

A SERIES OF INVESTIGATIONS and reports on flood retention and power dams, reservoirs and river surveys on the Ouachita and its tributaries in Arkansas, the Red River in Arkansas and Louisiana and the Yazoo and its tributaries in Mississippi has recently been completed for the Mississippi River Commission, Third District, by J. Albert Holmes, hydraulic engineer, of Boston and Chicago, and F. J. Summeril, of the University of Wisconsin.

CONSTRUCTION of a 32-km. railroad tunnel under the Strait of Gibraltar is feasible, according to a report of a commission appointed to study the possibilities of the project. It is expected the tunnel will cost $48,000,000.

BUILDING CODE ACTIVITY has recently been apparent both in Indianapolis, Ind., and in Jacksonville, Fla. In Jacksonville, a meeting of seven organizations of the city held a meeting sponsored by the Real Estate Board, at which a committee was appointed to sponsor the drawing up of a building code to place this city's regulations on a par with other cities of the country. At Indianapolis, according to news reports, William F. Hurd, the city building commissioner, called a state-wide gathering of building officials for Feb. 8, to consider the drafting of a model building code to be used for Indiana towns and cities.

THE UNIVERSITY OF ILLINOIS maintains fourteen research graduate assistantships in the Engineering Experiment Station to assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering. Two other such assistantships have now been established under the patronage of the Illinois Gas Association. These assistantships carry an annual stipend of $600 and freedom from all fees except those for matriculation and diploma. The appointments must be accepted for two years and lead to the degree of master of science. They are open to graduates of approved American and foreign universities and technical schools. Applications must be sent to Dean M. S. Ketchum before April 1.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Gen. Jadwin to Be Retired With Advanced Grade—House Committee Kills the Hydraulic Laboratory Bill

AN ORDER providing for the retirement on Aug. 7 of Major Gen. Edgar Jadwin, Chief of Engineers, as a lieutenant general, was one of the last official acts of President Coolidge. This action is based on General Jadwin's service during the construction of the Panama Canal, which allowed retirement under certain conditions with an advance of one grade. General Jadwin is due to be retired for age on that date.

Hydraulic Laboratory Bill Dies

The Ransdell hydraulic laboratory bill, after having passed the Senate and after having been the subject of extended hearings, was allowed to die in the rivers and harbors committee of the House. Proponents of the measure contend that the measure was filibustered to death by the reading of a long report which occupied practically all of the time at the final two sessions of the committee.

The advocates of the measure are of the opinion, however, that the treatment accorded this measure by Chairman Demsey of the House committee and by officers of the Corps of Engineers will insure the passage of the bill in the next Congress and will do more than any effort of their own to arouse the civilian engineers to the point where they will exert their political influence.

Nicaraguan Canal Survey Authorized

In spite of sectional opposition on the part of some of the Middle Western Representatives, the Senate resolution authorizing a resurvey of the Nicaraguan Canal route was passed by the House and signed by the President shortly before Congress adjourned. As passed by the House, the measure was amended so as to stress the language directing that an investigation be made of the practicability of enlarging the Panama Canal. It was even proposed that the study be confined entirely to the Panama Canal.

Middle Western Representatives opposed to the bill voiced the complaint that the Panama Canal had caused enough damage to the commerce of the interior without adding to the injury by taking steps to pave the way for the building of another canal. They pointed out that Middle Western industry is losing business in the Pacific Coast market to Eastern competitors who have the advantage of the cheaper water rates through the canal. Opponents of the bill also brought out that the Governor of the Canal Zone has reported that the Panama Canal, in its present condition, is adequate to serve the world's shipping for 30 years. It was further developed that officials of the Canal Zone are confident that the canal can take care of future business for 60 years by changing its locks from a duplicate system to a triplicate system.

On behalf of the bill it was stated that it is difficult to estimate what the transisthmian traffic will be in the years to come and that the capacity of the Panama Canal may be reached much sooner than is expected. The advocates of the measure also pointed out that all they propose is a resurvey to bring the report of the Isthmian Canal Commission down to date. There is nothing in the bill that will commit the government to the building of a canal across Nicaragua, it was stated. Although it was contended that the appropriation of $150,000 is not sufficient to finance the engineering studies called for, it was decided to leave the sum authorized at this amount.

During the course of the debate on the floor of the House, the charge was made several times that the movement back of the bill is so determined as to give rise to the suspicion that a large benefit is to be gained somewhere. The implication made by some of those advancing this charge is that engineering interests have become impressed with the possibilities of the section of the bill in which the President is authorized to consult such civilian engineers as he may deem necessary for the purposes of making the survey.

Opposition to Niagara Falls Treaty With Canada

Opposition of Mississippi Valley interests is given as the reason for the failure of the Senate to ratify the proposed treaty with Canada providing for the protection of the crest of the falls at Niagara against erosion and for the diversion, during the non-tourist season, of 10,000 sec.-ft. of additional water on each side of the river. When the treaty first came before the foreign affairs committee of the Senate a favorable report was expected when the Governor of New York advised that he would interpose no objection to such action. The objections from Mississippi Valley interests came unexpectedly and were based on the contention that all diversions from the Great Lakes should be settled at the same time. In this way it is hoped to provide for more diversion at Chicago than could be obtained otherwise. The argument is based entirely on the need of this water for navigation purposes in connection with the lakes-to-gulf waterway.

Tunnel of Delaware River at Philadelphia Proposed

The construction of a tunnel under the Delaware River connecting South Philadelphia, Pa., and Gloucester, N. J., is proposed, and a bill authorizing such tunnel introduced into the lower branch of Congress has been favorably reported by the House committee on interstate and foreign commerce. The tunnel would be so constructed as to form no obstacle to navigation.

Hoover Inauguration Celebration by San Francisco Engineers

The largest gathering ever held in the Engineers Club of San Francisco celebrated on March 4 the inauguration of one of its members as President of the United States. Guests of honor included six past-presidents of the founder societies, of which four are now Stanford University faculty members. Pride in the selection of this engineer as the nation's leader and confidence in national prosperity under his leadership were expressed.

The principal address was made by John L. McNab, the San Francisco attorney who nominated Mr. Hoover at the Kansas City convention. McNab stressed the importance of the engineer to civilization's progress and credited the marvelous development in modern times to engineering achievements. A congratulatory telegram sent from the meeting to Mr. Hoover claimed to bespeak the sentiments of the 50,000 Western members of the founder societies and concluded with the following:

"We look forward with confidence to national prosperity under your leadership; we know that your success will reflect in a better appreciation by the public of the importance to all lines of industry and commerce of that form of service which can be rendered only by the engineer, and finally we believe that you now have before you the greatest opportunity for service that ever has come to an engineer."

Missouri Pacific Plans to Lease 21 Southwestern Railroads

The Missouri Pacific Railroad has made application to the Interstate Commerce Commission for authority to acquire control by lease of 21 of its subsidiary companies in the Southwest now controlled by stock ownership, operating a total of approximately 3,000 miles, "in a manner not involving a consolidation of applicants and such carriers." It is stated that the plan of acquisition does not involve any financing on the part of the applicant.

The roads involved are: New Orleans, Texas & Mexico; International-Great Northern; St. Louis, Brownsville & Mexico; Orange & Northwestern; New Iberia & Northern; Iberia, St. Mary & Eastern; Houston & Brazos Valley; San Benito & Rio Grande; San Antonio, Uvalde & Gulf; Sugar Land; Asherton & Gulf; Asphalt Belt; San Antonio Southern; Austin Dam & Suburban; Beaumont, Sour Lake & Western; Houston North Shore; Natchez & Southern; Natchez & Louisiana Railway Transfer; New Orleans & Lower Coast; Port Smith Suburban; and Missouri Pacific Railroad Corporation in Nebraska.

The proposed leases, for 99 years, provide for the payment of 7 per cent annual dividends on the stock of the New Orleans, Texas & Mexico, which directly or indirectly controls most of the other companies.

Ship Repair Companies Combine in New York City

Six of the principal ship repair companies of the port of New York were brought under unified management on Feb. 28, when the recently organized United Dry Docks, Inc., took physical possession of the properties of the Morse Dry Dock & Repair Company, James Shewan & Sons, Inc., the Staten Island Shipbuilding Company, the W. & A. Fletcher Company, New York Harbor Dry Dock Company, Inc., and the Theodore Crane's Sons Company.

These properties comprise a total of 27 dry docks in New York harbor which have a lifting capacity of 160,000 tons. It is stated that these yards combined handle upward of 7,000,000 tons annually.

Edward T. Morse, of the Morse Dry Dock & Repair Company, is president of the new corporation.

Expert Reports on Montreal Terminal Problem

In his report on the Montreal terminal problem, which has just been made public, Frederick Palmer, British expert, lauds the plan of the Canadian National Railways to concentrate their services in a central terminal based on the existing tunnel station, but points out that the opportunity should not be lost of extending the project to create on the site a union depot serving both the Canadian National and Canadian Pacific railways.

The estimated cost of the proposed separate C.N.R. terminal is $46,000,000 and of the union passenger terminal scheme $83,700,000. The electrification of all island lines and the creation of a union passenger terminal, Mr. Palmer says, would open the way to suburban train services that might attract between 100,000,000 and 200,000,000 passengers yearly, reduce street congestion, afford rapid transit and bring big revenue to both the railways.

Mount Vernon Memorial Highway

It has been decided that the Mount Vernon Memorial Highway, from the District of Columbia to Mount Vernon, will follow the Potomac River. Congress has appropriated $4,500,000 for the construction of the road, which will be 15.4 miles long. The highway is to be completed in 1932, under a three-year program. In 1928 and 1929 $2,500,000 is available; for each of the years 1930 and 1931 $1,000,000 will be available. In the first year of construction heavy fills and hydraulic fills will be placed and probably some work on foundation for structures in certain localities will be done. Grading will be completed in the second year, and paving of the road and parking places will be begun. The third year will be devoted to the completion of paving, especially over heavy fills, to planting and to finishing the parking spaces. Bids for heavy fills will be advertised for soon.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Dallas, Tex., April 24-26.

* * * *

THE FLORIDA ENGINEERING SOCIETY will hold its annual meeting at Clearwater March 14-16. C. A. Browne, Orlando, is president, and J. R. Benton, Gainesville, is secretary.

ENGINEERS SOCIETY OF ST. PAUL—At its annual meeting the society elected for 1929: president, C. L. Motl, division engineer in the state highway department; vice-president, Albert Buenger; secretary, Carl C. Borchert.

DULUTH ENGINEERS CLUB—Officers elected for 1929 include: president, Martin Hokanson, manager of the testing department of the Marshall-Wells Company; vice-presidents, J. G. Macdonald and T. J. Shefchick; treasurer, F. C. Baluss; secretary, H. W. Richardson.

THE MINNESOTA FEDERATION OF ARCHITECTURAL AND ENGINEERING SOCIETIES held its annual meeting in St. Paul Feb. 22 and 23. Among the papers presented were those on "Mineral Taxation in Minnesota and Its Effect on the Iron Mining Industry," by E. P. Scallon, state representative and mining engineer, of Crosby, Minn., and "Aviation and Airports," by William N. Carey, superintendent, Bureau of Construction, St. Paul. The discussion was led by Charles E. Doell, secretary, Board of Park Commissioners, Minneapolis. The officers elected were: president, E. W. R. Butcher, chief engineer, Northern Ore Mines, Republic Iron & Steel Company, Duluth, Minn.; vice-president, W. G. Dorr, architect, Minneapolis. The annual meeting of the Minnesota Surveyors' and Engineers' Society was held at the same time. Officers of this society elected were: president, George A. Larson; secretary, C. L. Methven.

Personal Notes

ERIC A. BLACK has been appointed by the Newark (N. J.) City Commission assistant designing engineer in the transit bureau which is planning the city railway.

I. G. VASS, who was manager for the town of Galax, Va., from 1922 to Dec. 1, 1928, has since that date been serving as city manager of the town of Waynesboro, Va.

ERNEST S. ROSS has severed his connection with the Warren Brothers Company, Boston, Mass., and is now consulting highway engineer for the road department of the Nippon Oil Company, Tokyo, Japan.

ARNE LALAND, of Sandnes, Norway, who was previously with Louis Kampe, architect, Detroit, on structural steel and reinforced-concrete design, has been put in charge of design and construction of plant developments with the J. W. Cumming Manufacturing Company, Ltd., New Glasgow, N. S.

RUSSELL A. VAN NESS, resident engineer, Atchison, Topeka & Santa Fe Railway, has been appointed bridge engineer of the Atchison, Topeka & Santa Fe Railway System, to succeed the late A. F. Robinson. Mr. Van Ness was resident engineer on the company's new bridge over the Mississippi River at Fort Madison, Iowa.

J. RICH STEERS announces the reorganization of Henry Steers, Inc. contracting engineers, of New York City, and the formation of J. Rich Steers, Inc., which will continue the engineering and construction departments. Henry Steers, Inc., will continue the business of supplying sand and gravel.

Dr. GEORGE D. STRAYER, head of the educational department of Teachers' College, Columbia University, will serve as an expert to pass on the plans and specifications of new schools to be built in Baltimore out of a new $10,000,000 loan. The appointment has been made by the Board of School Commissioners and approved by the Public Improvement Commission.

JOHN W. DOTY, formerly chairman of the board of the Foundation Company, New York, announces the organization of the John W. Doty Corporation, for the purpose of engaging in engineering, construction, management and finance. Headquarters will be in New York City. Mr. Doty is president, Ralph H. Chambers vice-president and A. R. Murray secretary and treasurer of the new organization.

W. B. POLAND has been appointed by the Chinese government a member of the financial commission to draw up a new system of finance for China. Mr. Poland has recently completed a two-year contract with the Persian government as director of railways. Under his direction the preliminary location of the national railway between the Caspian Sea and the Persian Gulf was made and 150 km. of the grade was completed.

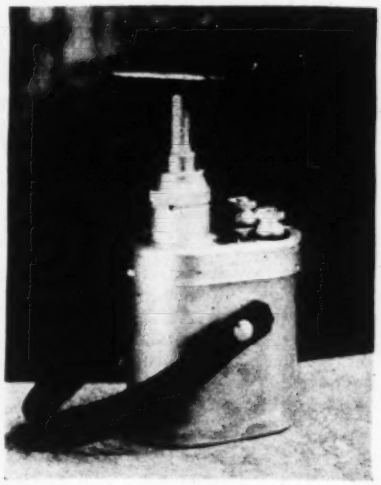
Obituary

WILLIAM D. HUDSON, head of the William D. Hudson Company, civil engineers, St. Louis, Mo., died on Feb. 25. He was 48 years old. Mr. Hudson had been identified with many engineering projects throughout the country, largely railroad, bridge and harbor work. While assistant bridge engineer of the Missouri Pacific Railroad he designed the Tower Grove viaduct over the Missouri Pacific and St. Louis-San Francisco railroads in St. Louis. His study of grade-crossing elimination in Toledo was the basis for a ten-year construction program by the city and railroads.

Construction Equipment and Materials

Pocket-Size Blasting Machine Works on Dynamo Principle

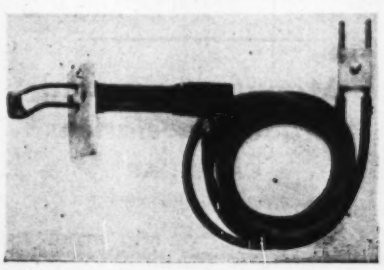
A new pocket-size blasting machine, which, according to the manufacturer, represents a departure in American electrical machine design, has been announced by the engineers of the Hercules Powder Company, Wilmington, Del. It is said to be the first machine



of American design to apply the dynamo principle in a unit of such compactness. It weighs only 4¾ lb. and will slip into an ordinary coat pocket. The dynamo principle is said to assure its permanent capacity in contrast to the old magneto type which lost power with age. This new unit is rated to fire ten electric blasting caps connected in series, but all tests have shown a 100 per cent power reserve.

Water-Cooled Electrode Holder for Carbon-Arc Welding

A new type of water-cooled carbon electrode holder for heavy-duty manual welding by the carbon-arc process has recently been announced by the Lincoln Electric Company, Cleveland, Ohio. Designed primarily to insure greater comfort and less fatigue for the welder operator, the manufacturer states that extensive tests have also shown that the new holder effects a marked economy in the use of carbon electrodes. For example, it is possible to weld with the arc tip of the carbon electrode projecting less than 3 in. from the carbon holder, which greatly reduces the vaporization of the carbon. Also it is possible to use smaller sized carbons with higher current density.

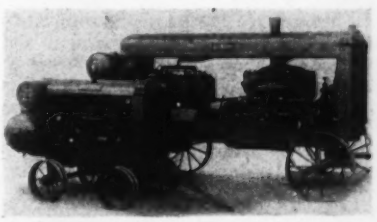


This new holder weighs only 3¼ lb., and in addition is said to be well balanced and easy to handle due to the extreme flexibility of the lead cable. One feature that contributes to the light weight of the holder is the utilization of the water hose to carry the cable also. The water flowing through the holder also acts as a cooling agent for the cables. By the use of this cooling agent the size cable to the holder is reduced to a fraction of the size necessary if it were not used.

The carbon holder consists of coiled copper tubing through which water constantly circulates, the carbon electrode being inserted through the coil. The carbon holders are manufactured in sizes for use with ¼-in., $\frac{5}{16}$-in., ⅜-in. and ½-in. carbons. A hand shield of compressed magnesium protects the operator's hand from the arc rays. The water-cooling system is incorporated also in the hand grip of the holder to keep it cool.

Portable Compressor of 360-Ft. Size Largest Yet Built

A new 360-cu.ft. portable engine-driven compressor recently announced by Schramm, Inc., West Chester, Pa.,



is claimed to be the largest unit of its type yet constructed. The company believes that its heavy-duty self-aligning clutch type coupling between the engine and the compressor is the principal reason back of the success of such a large-sized unit. The compressor is of the four-cylinder type, 7⅛x5 in. Parts are interchangeable between cylinders. The compressor is operated by a 6x7⅛-in. Buda engine and is equipped with all the features and refinements used in other Schramm compressor units, such as automatic cut-out, air cleaners on both compressor and engine, visible gasoline strainer, standard A.S.M.E. riveted tanks and one-piece frame. Steel wheel or rubber-tired trucks, as well as spring-mounted trailer trucks with artillery wheels and skid mounting for stationary and semi-portable installation, are available.

The accompanying illustration shows the new machine compared with the company's smallest unit, a 60-cu.ft. compressor.

Small Portable Pump Delivers 250 G.P.M.

A new model pump, weighing slightly more than 100 lb. and incorporating the features of portability, low cost operation and unusual capacity, has been announced by the Evinrude Motor Company, Milwaukee, Wis., for contractors' use in draining ditches, supplying concrete mixers with water and other usual work. The pump, which is described as being about the size of a large water bucket, is powered by an Evinrude 6-hp. twin-cylinder engine, the operation of which is said to be unusually smooth and

vibrationless. The pump has a capacity of 250 g.p.m. and is claimed to operate with ease under 50-ft. head. The manufacturers state the operating cost is about 1c. per 1,000 gal.

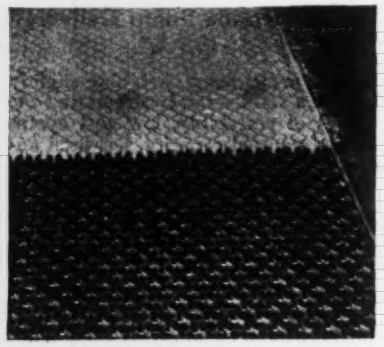
The pump has but one moving part, the bronze impeller, directly splined to the alloy steel shaft. A feature of the pump is that its flywheel acts as an umbrella-like protection over the magneto, shielding it from rain, spray and dirt. Waterproof cables connect to the sparkplugs. An effective muffler is provided. The capacity of this new model is said to be more than double that of last year's, although the weight has been decreased 10 per cent and the over-all size about 11 per cent.

Steel Armor Unit for Concrete and Asphalt Floors

For use in increasing the life of concrete and asphalt floors, the Blaw-Knox Company, Pittsburgh, Pa., announces a new armor unit designated as "Floorgard." It consists of a built-up continuous steel mat laid on the surface of the floor. The pattern is said to be designed so that traffic and stresses will be taken care of by the steel itself, distributing loads throughout a wide area of the floor. Furthermore, the concrete between the steel bars is in no way divided into separate portions, but is

monolithic with the rest of the concrete forming the floor body.

Installation of the unit requires no special tools or skill. The material arrives in a number of steel strips. They are set on edge as shown in the accompanying illustration and tied together by short tie rods which act as suporting members carrying one strip to another strip as well as tying the entire surface into a unit steel mat. It will be noted in the illustration that there are small steel lugs between adjacent strips of Floorgard at the points where the tie rods go through the steel strips. These lugs act as anchors to keep the steel strips in the plastic material and also as separators.

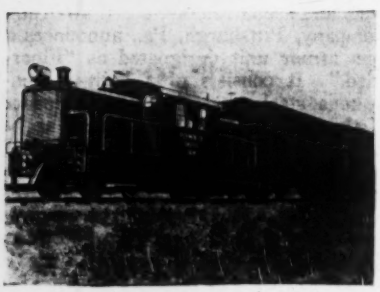


Since the armoring can be laid in any shape, it is particularly adaptable to use in partial areas of floors where traffic is greatest—for instance, around machine bases and in aisles. The Floorgard is made in various sizes of mesh to conform with varying conditions or sizes of truck wheels, weights of loads, types of traffic and other variations in service.

Under the name Pavegard, a similar steel armoring is used in connection with the strengthening of the surface of roads, streets, alleys, bridge floors and other forms of pavement ordinarily subjected to extremely heavy wear.

Diesel Locomotive in 60-Ton Size

A direct gear drive diesel locomotive with a capacity of 60 tons has recently been brought out by the Fate-Root-Heath Company, Plymouth, Ohio. This unit is especially adapted to general industrial haulage, quarries, sand and gravel plants, logging, mining, general construction work and short-line railroads. It is equipped with a Winton eight-cylinder diesel engine, 8½ in. bore and 12 in. stroke, using airless injection and developing 400 hp. at 700 r.p.m. If desired, it can also be equipped with two 200-hp. gasoline engines. The locomotive is 37 ft. long over the coupler knuckles, 11 ft. 8 in. high and 10 ft. wide.



The transmission is of heavy construction, affording four speeds forward and reverse. Shafts are of nickel chromium steel heat treated and carried on Timken, Hyatt and New Departure ball bearings. The jaw clutches are shifted by air cylinders.

The locomotive is built with either standard or special speeds. Standard speeds are 3, 6, 12 and 24 m.p.h., special speeds 4½, 9, 18 and 36 m.p.h. Tractive force of standard speeds, low gear, is 37,188 lb.; of special speeds, low gear, is 24,792 lb. With its two-truck construction this type of locomotive will negotiate sharp curves and rough track where other large locomotives are not usable. This 60-ton diesel completes the company's line of diesel-powered locomotives ranging from 10 to 60 tons.

Business Notes

CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., manufacturer of electric motor control, wiring devices and allied lines, announces a change in its name to CUTLER-HAMMER, INC.

MICHIGAN VALVE & FOUNDRY COMPANY has been purchased by Chicago and Detroit banking interests. The new officers and directors were elected on Feb. 11 and a new company was organized. R. J. Goldie, who has been in the automotive industry for a number of years with the Chalmers Motor Company and the Timken-Detroit Axle Company and has most recently been engaged in consulting engineering work, will have active charge of the company's business, serving as vice-president and general manager. The other officers of the company are W. F. Rockwell, president and chairman of the board, and E. S. Jackson, secretary-treasurer. Mr. Rockwell is also president of the Pittsburgh-Equitable Meter Company.

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, announces the appointment of C. M. Taylor as sales manager. Mr. Taylor graduated from Western Reserve University in 1916 and has been with the Lincoln Electric Company since, his service interrupted only by two years spent in the United States army air service. In 1923 he was promoted to factory manager and in 1925 was elected vice-president of the company, remaining as factory manager until his recent appointment as sales manager.

CEMENT GUN CONTRACTORS ASSOCIATION, 537 South Dearborn St., Chicago, Ill., held its second annual meeting in Chicago Feb. 18, 19 and 20. In addition to the election of officers for the ensuing year, a movement was started for the unification of the many patents covering various mechanical details and processes involved in cement-gun work. It is stated that when perfected this will enable members of the association to give positive guarantees against patent infringement suits. Steps were also taken to discourage unfair practices in bidding among members and to stop the practice among some general contractors of shopping bids or of beating down cement-gun prices after bids have been opened and contracts let.

WILLAMETTE IRON & STEEL WORKS and the Ersted Manufacturing Company have merged their hoist and lumber carrier business, which will in the future be handled by the Willamette-Ersted Company, Portland, Ore. A complete line of automotive hoists, cranes and lumber carriers is to be manufactured. The officers of the new organization are: C. F. Swigert, chairman of the board of directors; E. G. Swigert, president; A. J. Ersted, vice-president in charge of production; E. C. Pape, vice-president in charge of sales, and H. Black, secretary and treasurer.

BAY CITY DREDGE WORKS, Bay City, Mich., announces a change in its corporate name to BAY CITY SHOVELS, INC. The change involves a change in name only, no change in policy or ownership being contemplated. The new name more truly indicates the present principal product of the company, which is convertible power shovels.

HAYDITE MANUFACTURERS ASSOCIATION has recently been formed by the interests manufacturing Haydite, a lightweight concrete aggregate. The purpose of the association is to advertise this material, conduct research work, promote general distribution and use and in general to function similarly to other trade associations. Membership in the association is made up of the following companies, which operate a total of eight plants having a capacity of about 600,000 cu.yd. of concrete per year: Hydraulic-Press Brick Company, St. Louis, Mo., and Cleveland, Ohio; Western Brick Company, Danville, Ill.; J. H. Black Company, Buffalo, N. Y.; Cooksville Company, Ltd., Toronto and Montreal, Canada; Haydite Company, Kansas City, Mo., and Pittsburgh, Pa. The general offices of the association are in the Mutual Building, Kansas City, Mo., and its officers are B. W. Ballou, president (president, Haydite Company, Kansas City, Mo.); F. W. Butterworth, vice-president (general manager, Western Brick Company, Danville, Ill.); and Dan F. Servey, secretary-treasurer (vice-president, Haydite Company, Kansas City, Mo.).

Manufacturers and Trade Associations

CALENDAR

ANNUAL MEETINGS

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; annual convention, Asheville, N. C., April 15-17.

The Business Side of Construction

Heavy Construction Still Gaining Over Record of Year Ago

Residential Decline Is 16 Per Cent—Other Classes Except Roads Record Large Increases

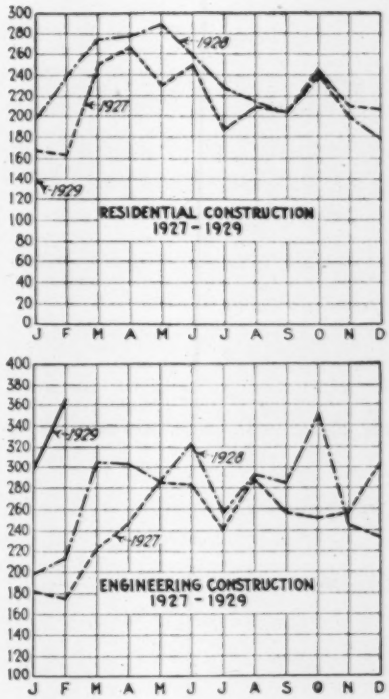
MANY business writers are referring to the "slump in construction." They are correct if they refer to residential building—one-third consisting of one- and two-family dwellings—which Chart I shows to have declined more than seasonally since December, 1928. For December, January and February the drop amounts to $110,000,000, or 16 per cent under the total for the three months a year ago.

Engineering construction, on the other hand, has not only been gaining but has been gaining to the remarkable amount of 27 per cent in the last three months as compared with those same months a year ago. January and February recorded cumulative totals of $762,000,000 in contracts awarded, or $351,000,000 more than in those two months of 1928. The figures are given in detail, by sections and classes of work, in the monthly tabulation on this page.

What parts of the country are contributing to these increases? The answer is, Practically every part. Comparing the month just past with February, 1928, it is seen that every section except the South, where the values for the two years are the same, and the Far West, where there was a drop of 16 per cent, recorded more than unusual advances: New England, 45 per cent; Middle Atlantic, 50 per cent; Middle West, 134 per cent; between the Mississippi and the Rocky Mountains, 48 per cent.

Analysis by classes of construction shows the same unanimity of activity. With the single exception of roads and streets, every class shows a heavy gain compared with figures for February, 1928. All classes of building gained, the figure for industrial work being $48,000,000 compared with $18,000,000 a year ago.

Will this volume be maintained? Demand for new structures as indicated by new capital issues continues unabated. The year closed with the largest volume of new securities issued in any month on record. In January the volume, though not quite as large as that for December, exceeded $1,000,000,000, in the face of continued tension in the money market and high rates levied for all classes of loans.



ENGINEERING CONSTRUCTION RISES, RESIDENTIAL BUILDING FALLS

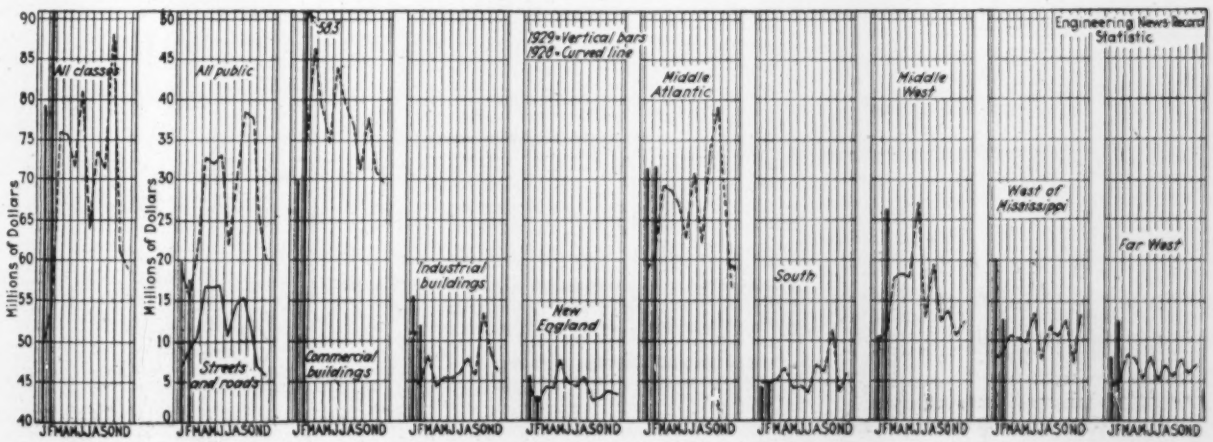
Industrial and miscellaneous corporation financing amounted to $706,000,000, or more than 72 per cent of the total

VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA, FEBRUARY, 1929

Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date	Canada
Water-works	$79	$385	$768	$2,508	$729	$195	$4,664	$7,465	.....
Sewers	142	1,917	324	2,304	301	374	5,362	11,641	$92
Bridges	23	1,070	119	3,506	817	41	5,576	13,344	500
Excavations, etc.	.....	82	40	400	134	151	807	11,864	500
Streets and roads	170	2,311	2,120	777	5,459	1,292	12,129	43,389	414
Industrial buildings	1,935	12,762	7,398	12,568	11,497	1,980	48,140	125,788	7,458
Commercial buildings	10,394	102,896	6,404	82,147	10,165	21,249	233,255	382,720	3,682
Federal government	.....	316	1,047	315	1,056	1,238	3,972	12,514	.....
Unclassified	50	4,567	166	289	21,610	24,196	50,878	153,071	1,461
February, 1929*	12,793	126,306	18,386	104,814	51,768	50,716	364,783	.....	14,107
January, 1929†	27,073	156,358	20,953	52,311	100,577	39,561	396,833	.....	11,247
February, 1928*	9,020	84,820	18,962	45,281	34,706	20,501	213,290	.....	4,744
Year to date, 1929	39,866	282,664	39,339	157,125	152,345	90,277	.....	761,616	25,354
Year to date, 1928	26,360	157,624	38,039	85,561	66,387	37,303	.....	411,274	17,319

*Four Weeks †Five Weeks



CONTRACTS AWARDED—AVERAGE WEEK PER MONTH—TOTAL U. S. BY CLASSES—ALL CLASSES BY SECTIONS

corporate offering, which percentage is the same as for December. Public utilities issues slightly exceeded those for December. Railroad financing aggregated $61,613,000, compared with $79,479,000 for December. The difficulty of selling municipal securities was reflected in the low total for these of $73,000,000, compared with $99,000,000 in January, 1928, when even then municipal sales were relatively light.

Materials Prices Continue Stable

Building-supply dealers look for increased business this year, according to an annual survey among 1,200 dealers conducted by the Universal Portland Cement Company, Chicago. Increased farm building is forecast uniformly in the agricultural states, particularly in the Middle West and Northwest. A larger volume of residential building is also predicted. Highway paving is expected to exceed that of 1928 with about the same amount of street and alley improvements. The survey covered dealer opinion in Illinois, Indiana, Michigan, Wisconsin, Iowa, Minnesota, Ohio, Pennsylvania and western New York.

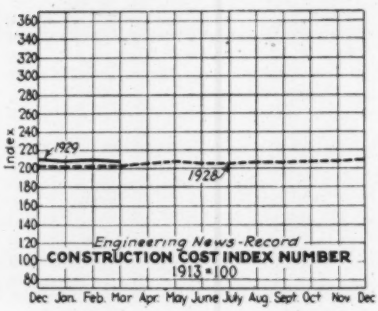
Meanwhile, although this should be regarded as the dull season, the unusually large volume of heavy construction contracts has maintained prices at the stable levels to which they have become accustomed.

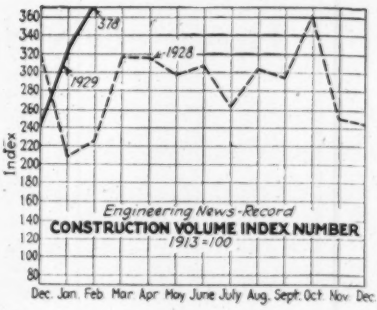
A continuing increase in steel production, due to growing demand, has increased price strength, particularly in the case of sheets, for which an advance of 10c. per 100 lb. was reported at Pittsburgh. Although the Carnegie Steel Company, followed by other mills, asks $1.95 for structural steel for second-quarter delivery, there is very little of this business, and $1.90 continues to be the price at which business is done. Ingot production in the Pittsburgh district averages 90 per cent and in Chicago 95 per cent.

In the lumber industry the policy of curtailment of production has been aided during the month by heavy rains in the Southern pine belt and snows in the Northwest fir region. The result has been advances in the price of yard stock. Structural pine is up $2.50 in Atlanta, $2 in Cincinnati, $1 in Detroit and $2 in Minneapolis. Fir is up $2.50 in Detroit and $2 in Minneapolis.

Large stocks of common brick have prevented any price advances. In the New York market there has been a decline of $1, both wholesale and retail, since the first of the year, and present prices of $15 for Hudson or Raritan and $18 for Connecticut hard brick, both at site, will continue for the present.

Red and white lead on Feb. 23 advanced ¼c. per pound in New York to $13.5c. for red (dry) and white (dry or in oil) and 15c. for red in oil.





ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

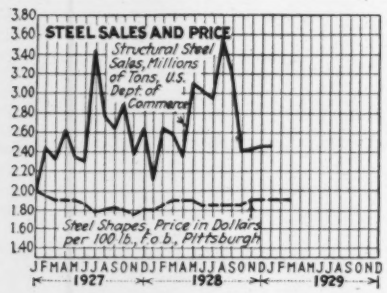
Construction Cost and Volume Index Numbers

E. N.-R. Cost			E. N.-R. Volume		
Mar., 1929		**207.78**	**Feb., 1929**		**378**
Feb., 1929		210.40	Jan., 1929		325
Mar., 1928		204.65	Feb., 1928		225
Peak June, 1920		273.80	1928 (average)		287
1928 (average)		206.78	1927 (average)		263
1913 (average)		100.00			
1928			1928		
January		203.90	January		208
February		204.65	February		225
March		204.65	March		318
April		206.40	April		316
May		207.00	May		299
June		206.15	June		308
July		206.65	July		266
August		207.29	August		306
September		207.29	September		296
October		207.71	October		363
November		209.46	November		251
December		210.16	December		244
1929			1929		
January		209.40	January		325

*Corrected for price change since 1913.

Current Unemployment is Seasonal

The surplus of building mechanics and highway workers reported for February by the Department of Labor is mostly seasonal. Cold weather was especially troublesome in Cleveland and Chicago, in the latter city permitting structural iron workers only five days of work for the month. Conditions in the principal cities are stated briefly in the following paragraphs.


STEEL SALES AND PRICE
Structural Steel Sales, Millions of Tons, U.S. Dept. of Commerce
Steel Shapes, Price in Dollars per 100 lb., f.o.b., Pittsburgh
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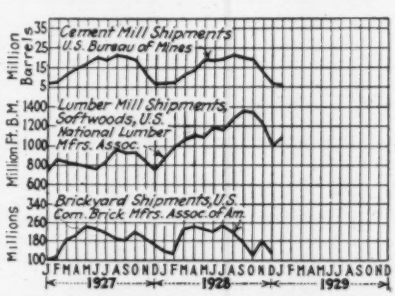
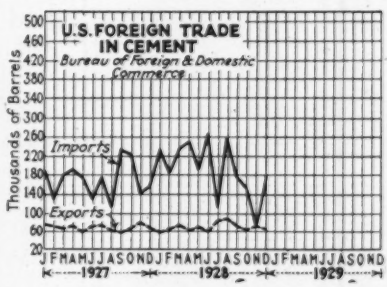
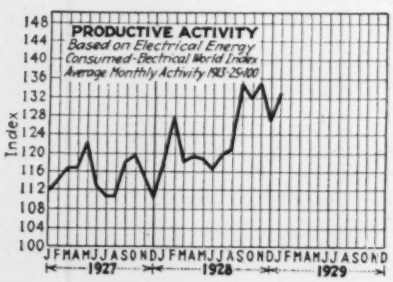
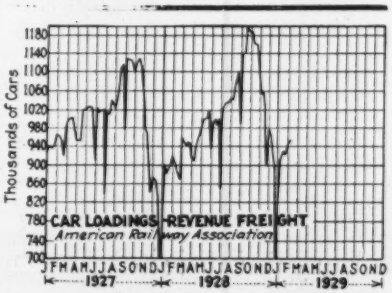
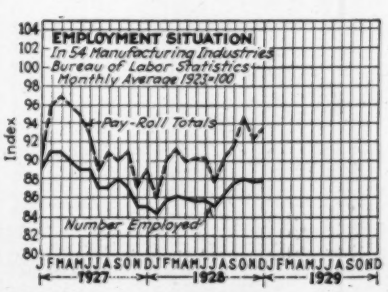
1927 1928 1929


Millions of Barrels
Cement Mill Shipments U.S. Bureau of Mines
Millions Mill. Ft. B.M.
Lumber Mill Shipments, Softwoods, U.S. National Lumber Mfrs. Assoc.
Brickyard Shipments, U.S. Com. Brick Mfrs. Assoc. of Am.
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


U.S. FOREIGN TRADE IN CEMENT
Bureau of Foreign & Domestic Commerce
Thousands of Barrels
Imports
Exports
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


PRODUCTIVE ACTIVITY
Based on Electrical Energy Consumed-Bechtrical World Index
Average Monthly Activity 1923-25=100
Index
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


Thousands of Cars
CAR LOADINGS-REVENUE FREIGHT
American Railway Association
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


EMPLOYMENT SITUATION
In 54 Manufacturing Industries
Bureau of Labor Statistics
Monthly Average 1923=100
Index
Pay-Roll Totals
Number Employed
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929

STEEL SALES—MOVEMENT OF MATERIALS—ELECTRICAL ENERGY CONSUMED—CAR LOADINGS—EMPLOYMENT AND PAY ROLLS

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.25@1.40	$0.60@0.70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.62½	1.00@1.10	1.00@1.37½	1.00	$0.65	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	.....	1.75	.25@.40
Boston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45@.80
Cincinnati	1.62½	1.37½	1.37½	.97½	1.37½	1.37½	.40@.60
Chicago	1.62½	1.10@1.50	1.00@1.50	.90@.96¼	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Dallas	1.67½	1.12½	1.25	.40@.75	1.25	1.25	.30@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.37½@.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.37½@.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	.30@.75
Los Angeles	1.25	1.00	1.00	1.12½	.87½	1.00	.50
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.40@.50
Montreal	1.25	.75	.75	.40	.....	.90	.30
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.75
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	.....	1.50	.40@.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.40@.75
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.50	1.12½	1.25	1.00	1.12½	1.25	.70

Philadelphia—Unemployment in all trades highest in eight years. Men working below scale. Iron workers on strike against open shop.

St. Louis—About one-third of the building workers idle. A bill sponsored by the Missouri State Federation of Labor and now before the Senate labor committee, proposes to reduce the working day from ten hours to eight and increase wages for common labor from $0.40 to $0.65, for carpenters from $0.75 to $1.25 and for hoisting engineers from $0.85 to $1.50. The bill states that road or bridge labor shall receive the wage rate for his trade current in the locality in which the work is being done. This, of course, enlists the interest of the contractor doing work in more than one city.

The average skilled wage for building trade mechanics for March is $1.35¾ per hour, the same as in February, and compares with $1.33⅜ a year ago. The average rate for common labor is 55.09c., compared with 56.4c. in February and 54.75c. in March, 1928.

Public Financing in February

Long-term financing by states and municipalities in February totaled $84,975,864, compared with $132,724,920 last year. For the two months of 1929 the total of all state and municipal financing was only $158,326,852, the smallest figure for the first two months of any year since 1921.

Despite this reduction, sales of individual bond issues show considerable decline in prices and resulting high interest rates. Most municipalities are raising money only for the most needed public improvements.

The total of new state and municipal bond issues reported approved during February was $13,309,998, covering programs of 71 communities in 22 states. This compares with $8,246,000 a year ago and $15,326,000 in February, 1927.

Among the important authorizations were the following: $2,750,000 Hidalgo County, Texas, water; $1,600,000 La Feria, Tex., water; $1,800,000, Maverick County, Texas, roads; $600,000, Port Jervis, N. Y., water-works; $530,500, Scarsdale, N. Y., school district; and $500,000, Winchester, Va., various improvements.

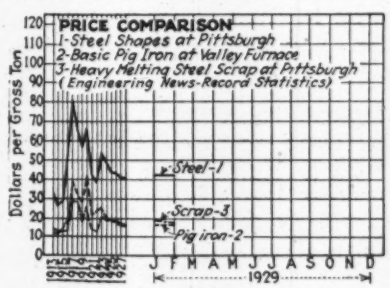
The following table, compiled by the *Daily Bond Buyer*, presents a comparison of bonds approved by months for the past three years:

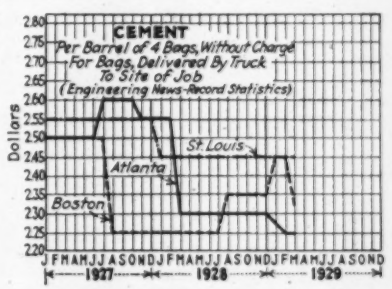
	1929	1928	1927
	(000 omitted)		
January	$26,950	$14,140	$11,909
February	13,309	8,204	15,326
March		21,636	23,615
April		77,465	75,778
May		136,989	79,033
June		45,609	73,185
July		59,211	38,939
August		22,010	21,386
September		16,870	13,372
October		12,096	12,017
November		345,933	127,933
December		23,244	68,526
Total	$40,260	$783,412	$560,714

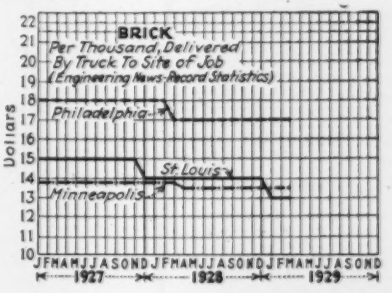
The principal financial development in February was the Federal Reserve Board's open disapproval of the growing volume of loans by individuals and corporations in the call money market. These "outside" funds thus made available for speculation have to some extent carried the situation beyond banking control. Corporate loans are not subject to control, and there are reasons why it might be dangerous to have them so. Even though prohibited by law, these funds would still be in existence and would be used in one way or another, such as for the outright purchase of securities or for too rapid expansion of industrial equipment.

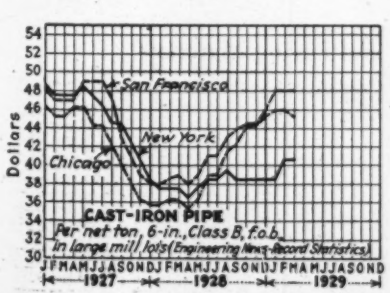
Skilled Machinists in Demand

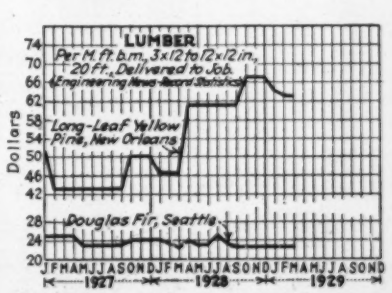
The machine-tool industry reports that because of the difficulty of obtaining skilled workmen in the face of excellent demand for machinery, manufacturers are ordering automatic machines and high-speed tools instead of enlarging their plants. New orders are well distributed as to size and territory.

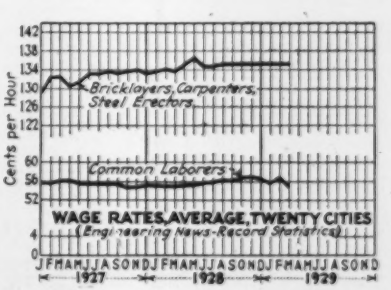



CEMENT
Per Barrel of 4 Bags, Without Charge For Bags, Delivered By Truck To Site of Job
(Engineering News-Record Statistics)
Dollars
St. Louis
Atlanta
Boston
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


BRICK
Per Thousand, Delivered By Truck To Site of Job
(Engineering News-Record Statistics)
Dollars
Philadelphia
St. Louis
Minneapolis
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


Dollars
San Francisco
New York
Chicago
CAST-IRON PIPE
Per net ton, 6-in., Class B, f.o.b. in large mill lots (Engineering News-Record Statistics)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


LUMBER
Per M. Ft. b.m., 3x12 to 12x12 in., 20 ft., Delivered to Job.
(Engineering News-Record Statistics)
Dollars
Long-Leaf Yellow Pine, New Orleans
Douglas Fir, Seattle
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


Cents per Hour
Bricklayers, Carpenters, Steel Erectors
Common Laborers
WAGE RATES, AVERAGE, TWENTY CITIES
(Engineering News-Record Statistics)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929

PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per bbl., quoted by manufacturers and dealers, delivered by truck to contractors, *without charge for bags*. Cash discount not deducted.

	Feb. 7, 1929	One Month Ago	One Year Ago
Atlanta	$2.25	$2.10	$2.45
Baltimore	2.65	2.65	2.50
Birmingham	2.60	2.60	2.40
Boston	*2.25@2.40*	2.45	2.05f.o.b.
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Chicago (f. o. b.)	2.05	2.05	2.05
Cincinnati (f. o. b.)	2.22	2.22	2.23
Cleveland (f. o. b.)	2.24	2.24	2.24
Dallas	2.15	2.15	2.05f.o.b.
Davenport (f. o. b.)	2.24	2.24	2.24
Denver	2.55	2.55	2.85
Detroit (f. o. b.)	1.95	1.95	1.90
Duluth (f. o. b.)	2.04	2.04	2.04
Indianapolis, (f. o. b.)	2.09	2.09	2.19
Jersey City	2.25	2.35	2.13f.o.b.
Kansas City, Mo.	2.20	2.20	2.10f.o.b.
Los Angeles	2.66	2.66	2.50
Milwaukee (f. o. b.)	2.20	2.20	2.20
Minneapolis (f. o. b.)	2.22	2.22	2.22
Montreal (f. o. b.)	1.70	1.70	1.41
New Orleans	2.65	2.35	2.07f.o.b.
New York	2.25	2.25@2.35	2.25@2.35
Peoria (f. o. b.)	2.22	2.22	2.22
Philadelphia	2.40	2.40	2.40
Pittsburgh (f. o. b.)	2.05	2.04	2.04
St. Louis	2.45	2.45	2.05f.o.b.
St. Paul (f. o. b.)	2.22	2.22	2.22
San Francisco	2.41	2.41	2.41
Seattle	2.70	2.70	2.65
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Leeds, Ala.	$1.65
Buffington, Ind.	1.80	Lehigh Valley District	1.75
Clinchfield, Ga.	1.65	Mason City, Ia.	1.80
Fordwick, Va.	2.05	Mitchell, Ind.	1.90
Hannibal, Mo.	1.90	North Birmingham, Ala.	1.45
Hudson, N. Y.	1.75	Richard City, Tenn.	1.85
Iola, Kan.	1.85	Steelton, Minn.	1.85
Kingsport, Tenn.	2.05	Universal, Pa.	1.80
La Salle, Ill.	1.90	Wyandotte, Mich.	1.70

SAND AND GRAVEL—Dealers' quotations per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds.

	Gravel 1½ In.	Gravel ¾ In.	Sand
Atlanta, per ton	$3.50	$3.50	*$2.40*
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb.)	3.00	3.00	2.65
Boston, per ton	**2.00**	2.00	1.50
Chicago	2.25	2.25	2.25
Cincinnati, per ton	1.90	1.90	1.60
Cleveland	2.60	2.60	2.50
Dallas	*2.40*	*2.40*	2.25
Denver (2,700 lb.)	1.80	1.80	1.30
Detroit (2,600 lb.)	3.25	3.25	2.75
Kansas City, Mo.	....	....	....
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800 lb.) (3,000 lb.)	2.40	2.40	**1.25**
Montreal, per ton	1.90	1.50	1.20
New Orleans (2,700 lb.) (2,500 lb.)	3.75	3.75	2.75
New York	3.25	3.25	2.00
Philadelphia, per ton	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh, per ton	2.40	2.40	2.60
St. Louis, per ton	**2.35**	**2.25**	**2.00**
San Francisco (2,800 lb.)	1.75	1.75	1.50
Seattle (3,200 lb.) (2,850 lb.)	2.00	2.00	2.00

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Dealers' quotations per cu.yd., delivered. Weight, 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$3.50	$3.50
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.40	2.40
Chicago, Limestone	2.25	2.25
Cincinnati, per ton	2.50	2.50
Cleveland, per ton	2.70	2.70
Dallas	3.25	3.40
Denver, Granite (2,700 lb.)	2.50	2.50
Detroit, Limestone, per ton	3.00	3.00
Kansas City, Limestone, (2,450 lb.)	2.00	2.00
Los Angeles, per ton	2.00	2.00
Minneapolis, Limestone (2,600 lb.)	2.40	2.40
Montreal, per ton	2.10	2.10
New York, Limestone	3.25	3.25
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
St. Louis, per ton (2400 lb. per cu.yd.)	1.90	1.90
San Francisco, Trap rock (2,400 lb.)	1.65	1.65
Seattle, (2,700 lb.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.30	1.30	....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Dealers' quotations on hollow building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.075	$0.104	$0.142	$0.189	$0.21
Baltimore	.105	....	.20	....	.26
Birmingham	.09	.127	.174	.218	.26
Boston	.08	.105	.145	.185	.25
Chicago	.076	.104	.142	.182	.202
Cincinnati	.074	.105	.136	.175	.205
Cleveland	.064	.088	.128	.171	.19
Dallas	.096	.12	*1.18*	.284	....
Denver	.0975	.135	.175	.2125	.25
Detroit	.096	.132	.18	.235	.261
Kansas City	.0525	.077	.158	....	.242
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0675	.0845	.131	.134	.1896
Montreal	.12	....	.22	....	.315
New Orleans	.086	.125	**.162**	.212	.247
New York	.0864	.1296	.162	....	....
Perth Amboy, N.J. (f.o.b.)	....	....	....	.252	.312
Philadelphia	.11	.145	.22	**.27**	.34
Pittsburgh	.068	....	.1175	....	.1726
St. Louis	.078	.105	.145	.175	.21
San Francisco	.108	.156	.255	....	....
Seattle	.08	.11	.18	....	....

BRICK—Dealers' quotations, delivered, per thousand are as follows:

	Common	Paving 3x8¼x4-in.	Paving 3¼x8¼x4-in.
Atlanta	$14.75	$38.00*	$45.00†
Baltimore	*14.00*	40.00	45.00
Birmingham	15.00	32.00*	36.00†
Boston	*17.00*	*43.50*	50.00
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	**15.00**	35.00	....
Denver, salmon	12.00	....	....
Detroit	15.50	35.50	38.50
Kansas City	16.00	....	....
Los Angeles	11.00	....	....
Minneapolis	13.50	....	....
Montreal	20.33	....	....
New Orleans	16.50	40.00*	50.50
New York	15@18	45.00	51.00
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	40.50	45.00
St. Louis, salmon	13.00	40.00	45.00
San Francisco	14.50	40.00	45.00
Seattle	14.00	50.00	55.00

*2¾x8¼x4 in. †3x8¼x4.

LIME—Dealers' quotations, delivered to job:

	Hydrated, per Ton—Finishing	Hydrated, per Ton—Common	Lump, per Barrel—Finishing	Lump, per Barrel—Common
Atlanta	$27.50	$17.50	....	....
Baltimore	20.00	14.00	$2.55†	....
Birmingham	22.00	16.00	3.00†	$2.00†
Boston	21.00	14.50	3.80*	2.90*
Chicago	*17.00*	*15.00*	*17.00‡*	1.50†
Cincinnati	18.00	13.20	....	13.20‡
Cleveland	20.00	16.00	2.50†	2.50†
Dallas	**20.00**	....	....	18.00‡
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	24.00	13.00	2.75†	2.75†
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	....	1.70†
Montreal	....	....	....	15.00‡
New Orleans	....	....	2.60	1.60†
New York	21.00@22.00	14.00@15.00	4.00@4.10*	3.15@3.25*
Philadelphia	22.00	15.00	....	....
Pittsburgh	21.00	19.00	18.00‡	17.00‡
St. Louis	24.00	18.00	2.75†	2.10*
San Francisco	27.50	20.00	....	1.70†
Seattle, paper sacks	36.00	24.00	....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@.20	Minneapolis, f.o.b.	$0.13
Brooklyn and Queens	15@.17	New Orleans	.22
Cleveland	.17@.18	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, f.o.b., quarry, Bangor, Pa., per square:

No. 1 Clear	$9.50@$13.00
No. 1 Ribbon	8.25@ 9.25
Medium Clear	8.00@ 9.50

Road and Paving Materials

PAVING STONE—Dealers' quotations, f.o.b., in carloads or in cargo lots, for granite blocks, 4x8x4-in., dressed:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.50 per sq.yd
Minneapolis, Sandstone, 4½x8.5 in.	**2.80** per sq.yd
Montreal	104.75 per M.
New Orleans	**2.80** per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd.	150.00 per M.
Philadelphia	125.00 per M.
St. Louis, 4x5x8 to 12 in.	3.50 per sq.yd
San Francisco, Basalt block, 4x7x8 in.	70.00 per M.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Dealers' quotations, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.40
Chicago	3½	16	2.10
Cincinnati	3½	16	2.35
Dallas	4	18	3.90
Kansas City	3½	16	2.50
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	*2.25*
New York	3½	16	2.70
St. Louis	3½	16	2.35

FLAGGING—Dealers' quotations, alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.

CURBBING—Dealers' quotations: *New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16 in., f.o.b., **$1.00** per lin. ft.; roundings, **$1.50** per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
Atlanta (Mexican)	*$22.55*	$18.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	24.50	18.25
Chicago (Texas)	24.50	21.30
Cincinnati (Kentucky Rock)		12.30
Cleveland	24.00	20.00
Dallas (Texas)	**26.00**	...
Denver (California)	35.00	
Detroit (Mexican)	24.00	19.00
Kansas City, Mo. (Texas)	27.30	25.30
Los Angeles ("D" Grade, California, f.o.b., El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	25.00	.....
Minneapolis, (Stanolind, f.o.b., Twin Cities)	*25.10*	*19.10*
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	22.50	18.50
Philadelphia (Mexican)	20.00	18.00
Pittsburgh (Standard Oil)	**24@26**	**18@20**
St. Louis (Mexican)	23.50	19.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, California, f.o.b., Richmond refinery)	19.50	13.50

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0525
Dallas, 40@50% asphalt	.06
Dallas, 50@60% asphalt	.06
New York, 40@50% asphalt (at terminal)	.06
New York, 50@60% asphalt (at terminal)	.06
St. Louis, 40@50% asphalt	.0418
St. Louis, 50@60% asphalt	.0418

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	$16.50@$17.00
Pittsburgh, basic, incl. freight ($1.76) from Valley	19.26

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	3.50	3.50
New York, warehouse, delivered, up to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b., (Feb. 28, 1929)	1.90	1.90
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.15	3.15

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.30@3.00
Cleveland, warehouse, delivered	2.25@3.00
Dallas, warehouse, delivered	3.50
New York, warehouse, delivered, over 5 tons	2.85
Pittsburgh, large mill lots, stock lengths, f.o.b.	2.00
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Dealers' quotations per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$15.00	$19.00	$14.00	$18.00	$21.50	$16.00
2.5	16.00	20.00	15.00	19.00	24.00	17.00
3.0	17.50	22.50	16.50	21.00	...	19.50
3.4	20.00	24.50	18.00	22.50	30.00	21.50

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and dealers, delivered in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse Delivery: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.30	$1.13	$1.22
049	28	1.26	1.29	1.76	1.70	1.38	1.55
068	35	1.54	1.58	2.18	2.10	1.67	1.91
093	40	1.98	2.03	2.79	2.65	2.00	2.46
126	57	2.45	2.51	3.45	3.30	2.55	3.03
153	68	2.92	2.99	4.13	3.95	3.15	....
180	78	3.35	3.43	4.73	4.50	3.47	...

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base size

	Blue Annealed No. 10	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	$3.80	$4.65
Cleveland, warehouse, delivered	3.25	3.60	4.45
New York, warehouse, delivered	3.90*	4.00	4.75
Pittsburgh, large mill lots, f.o.b.	2.10	2.85@2.90	3.60
St. Louis, warehouse, delivered	3.45	4.10	4.95
San Francisco, warehouse, delivered	3.35	5.80	5.40

*Up to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	121½%
Galvanized steel rigging and guy rope	71½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
Special steel round strand rope	30%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations on structural rivets, round-head, ¾-in., full kegs, per 100 lb.:

Chicago, warehouse, delivered	$3.60
Dallas, warehouse, delivered	4.75
New York, warehouse, delivered	4.50*
Pittsburgh, large mill lots, f.o.b.	2.90
St. Louis, warehouse, delivered	3.75
San Francisco, warehouse, delivered	5.75
Seattle, warehouse, delivered	3.75

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill, per package $11.20

SHIP SPIKES—Dealers' quotations per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Dealers' quotations per 100 lb. keg, base, delivered from warehouse stocks, also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.75	$3.30	**$3.15**	$3.05	$3.85	$3.35	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$12.50@$13.00	$15.75@$16.25	$15.00
Stove plate	8.75@9.50	15.00@15.50	10.50@11.00*
No. 1 machinery cast	15.00@17.00	17.50@18.00	13.00*
Machine shop turnings	8.25	10.00@10.50	9.00
Cast borings	**7.50@8.00**	*11.50@12.00*	10.50
Railroad malleable	13.00@14.00	19.00@19.50	13.00*
Re-rolling rails	*13.50@13.75*	17.50@18.00	16.00
Re-laying rails, 56@60 lb.	23.00@24.00	23.00@25.00	.....
Heavy melting steel, No. 1	12.50@*12.85*	15.75@16.25	15.50
Iron and steel pipe	11.75@*12.00*	12.00@12.50	9.00

*Net ton.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71*
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15†
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15†		

*Except iron or steel pipe and fittings. †Minimum weight on structurals, 60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mil lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	34@36	34@36	34@36

RAILWAY TIES—Dealers' quotations, f.o.b., for fair-sized orders:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application		
Birmingham	Southern pine, untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	1.20	1.70
	Red oak, creosoted	1.45@1.60	*1.95@2.10*
San Francisco	Sap pine or cypress, untreated	1.00	1.50
	Douglas fir, green, untreated	.82	1.14
	Douglas fir, empty cell, creosoted	1.73	2.32
Montreal	Birch or maple, untreated	.75@1.25	.75@1.25
	Birch or maple, creosoted	1.20@1.30	1.50@1.60

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb., f.o.b., Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, ⅜-in. and larger	$2.80	$3.55	$3.50	$3.55@$3.70	$3.85
Track bolts	3.80	4.55	4.50	4.55@4.75	4.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.50	.....	.....

Tie plates: Price at Pittsburgh and Chicago mills, $2.15 per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	54%	41%	51%	38%
Cleveland, warehouse, delivered	55½%	43½%	53½%	40½%
New York, warehouse, delivered	50%	36%	45%	32%
Pittsburgh, large mill lots, f.o.b.	62%	50½%	59%	47½%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Cast Iron Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots of pipe:

	4-In.	6-In. and Over
Birmingham mill	$41.00	$38.00
Burlington (N. J.) mill	42.00	39.00
Chicago	48.20@49.20	45.20@46.20
New York	44.60	41.60
Pittsburgh	49.50	46.50
St. Louis	46.60	43.60
San Francisco	51.00	48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Dealers' quotations, delivered, in cents per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.20	$0.34	$0.75	.....	$1.93	.....	.....
Baltimore	.16	.30	.58	.....	1.93	.....	$6.50
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.175	.285	.53	1.25	2.10	3.25	5.75
Chicago	.16	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.144	.224	.432	.80	1.44	2.304	4.8175
Cleveland	.18	.28	.54	1.30	2.34	4.68	7.18
Dallas	.256	.42	.794	1.70	3.00	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.21	.29	.52	.....	1.90	3.80	.....
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis	.16	.25	.50	1.15	1.84	3.49	4.97
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	.18	.30	.54	1.02	1.95	.....	.....
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	1.025	1.845	3.60	5.6375
Pittsburgh	.0945	.147	.2835	.85	1.53	3.024	4.8175
St. Louis	.1645	.182	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.26	2.16	3.60	.....
Seattle	.22	.30	.54	1.26	2.16	3.60	.....

CLAY DRAIN TILE—Dealers' quotations, delivered, per 1,000 lin.ft.:

Size, In.	New York	Birmingham	St. Louis	Dallas	San Francisco	Seattle
3	$40.00	$45.00	$50.00	.....	.....	$40.00
4	45.00	56.00	50.00	$73.00	$67.50	60.00
5	50.00	80.00	85.00	110.00	86.25	.....
6	78.00	105.00	85.00	118.00	112.50	90.00
8	130.00	175.00	195.00	150.00	187.50	.....

Miscellaneous

LINSEED OIL—Dealers' quotations on raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York....$0.11 Chicago....$0.114 Minneapolis....$0.119

WHITE AND RED LEAD—Dealers' quotations per 100-lb. keg, base price, f.o.b., New York: White, dry or in oil, $13.50; Red, dry, $13.50; Red, in oil, $15.00.

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	5.65@ 5.75
Soda ash, 58% in bags, per 100 lb.	1.32@ 1.35
Chlorine, liquid, cylinders, per lb.	.05@ .08
Bleaching powder, in drums, f.o.b. works, per 100 lb.	2.00@ 2.10

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¼-in., 8-ft.; ⅜-in., 6-ft.; ½-in., 4½-ft.; 1-in., 3½-ft.; 1¼-in., 2-ft., 10-in.; 1½-in., 2-ft. 4-in. Following are dealers' quotations per pound for ½-in. and larger, delivered in 1,200-ft. coils:

Atlanta	$0.21	Kansas City	$0.29
Baltimore	.22½	Los Angeles	.25
Birmingham	.26	Minneapolis	.22
Boston	.25	Montreal	.24½
Chicago	.20	New Orleans	.23½
Cincinnati	.21	New York	.21
Cleveland	.21	Philadelphia	.24
Dallas	.21	San Francisco	.20½
Denver	.23	Seattle	.20½
Detroit	.24	St. Louis	.19½

ROOFING MATERIALS—Dealers' quotations, f.o.b., New York, to contractors in carloads:

Asphalt felt, per 100 lb.	$2.60
Tar felt, per 100 lb.	2.60
Asphalt coating, per gal.	.34½
Tar pitch, in 350 lb. barrels, per ton	28.00

REPARED ROOFINGS—Dealers' quotations to contractors, in carloads, f.o.b. New York.

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.12½
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:

AA .....83% A .....86% B.....88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots, under 200 lb.

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.1925	.2125
Birmingham	.22	.245	Montreal	.195	.22
Boston	.23	.25	New Orleans	.235	.26
Chicago	.195*	.22*	New York	.26‡	.2825‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.24	.29	St. Louis	.215	.235
Denver, f.o.b.	.19	.2125	San Francisco	.1625	.1925
Kansas City, Mo.	.2025	.2225	Seattle	.16	.185

*Quantities above 500 lb but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Dealers' quotations on rough Douglas fir, No. 1 common, at yards. For delivery to contractor at site of job, add $1.50 to $5 per M. ft.:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Dealers' quotations, f.o.b., in carloads, No. 1 Common, rough, per M. ft. b.m. For delivery to job from stock, in truckloads, add $10 per M. ft.:

	20 Ft. and Under Long-Leaf Yellow Pine	Up to 32 Ft. Douglas Fir
3x4 to 8x8	$41.00	$42.00
3x10 to 10x10	48.50	42.00
3x12 to 12x12	58.50	42.00
3x14 to 14x14	70.50	43.00

New York—Quotations per M. ft., b.m., wholesale, for long-leaf, yellow-pine timbers, No. 1 common, rough, in quantities of 35,000 ft. or more, within lighterage limits:

	20 Ft. and Under	22 and 24 Ft.
3x4 to 8x8	$43.00@$45.00	$44.00@$46.00
3x10 to 10x10	50.00@ 52.00	51.00@ 55.00
3x12 to 12x12	57.00@ 59.00	58.00@ 60.00
3x14 to 14x14	65.00@ 67.00	66.00@ 68.00

Other Cities—Dealers' quotations, delivered, No. 1 Common, rough, per M. ft:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$47.50	.....	.....	.....	$67.50	.....
Baltimore	36.00	$50.25	$54.00	$61.00	75.00	$50.25
Birmingham	45.00	.....	.....	.....	60.00	.....
Boston	48.00	47.00	47.00	47.25	57.00	50.00
Cincinnati	38.00	49.00	47.00	47.00	42.00	53.00
Cleveland	65.00	65.00	.....	.....	65.00	65.00
Dallas	65.00	55.00	57.50	.....	65.00	55.00
Denver	.....	59.00	.....	.....	57.00	55.00
Detroit	62.50	51.50	.....	.....	68.50	51.50
Kansas City, Mo.	42.80	39.75	.....	.....	57.50	39.75
Los Angeles	.....	44.00	.....	.....	.....	44.00
Minneapolis	57.00	52.25	.....	.....	57@59	52.25@53.75
Montreal	50.00	55.00	.....	.....	49.00	48.00
New Orleans	50.00	46.00	.....	44.00	67.00	63.00
Philadelphia	52.00	35.00	42.00	40.00	55.00	35.00
St. Louis	46.00	39.00	.....	.....	55.00	40.50
Seattle	.....	22.50	.....	.....	.....	22.50

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft.	
	Pine*	Fir†	Hemlock	Pine*	T. & Gr. Fir†
Atlanta	$60.00	.....	.....	$40.00	.....
Baltimore	56.00	$45.00	$45.00	.....	.....
Birmingham	36.00	.....	.....	43.00	.....
Boston	44.00	43.00	42.00	48.00	$47.75
Cincinnati	35.00	40.00	33.00	35.00	48.00
Cleveland	60.00	55.00	.....	65.00	58.00
Dallas	60.00	.....	.....	.....	.....
Denver	.....	50.00	.....	.....	51.00
Detroit	45.00	42.00	.....	47.50	45.00
Kansas City, Mo.	50.50	45.75	.....	44.75	36.75
Los Angeles	.....	38.00	.....	.....	57.00
Minneapolis	52.00	46.00	.....	52.00	47.00
Montreal	45.00	48.00	40.00	85.00	70.00
New Orleans	43.00	40.00	.....	50.00	46.00
Philadelphia	55.00	36.50	36.00	52.00	36.50
St. Louis	42.50	39.00	38.00	38.00	35.00
Seattle	.....	20.00	.....	.....	22.00

*Long-leaf yellow pine. †Douglas fir.

PILES—Dealers' quotations per lineal foot, pine, with bark on, f.o.b., New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41